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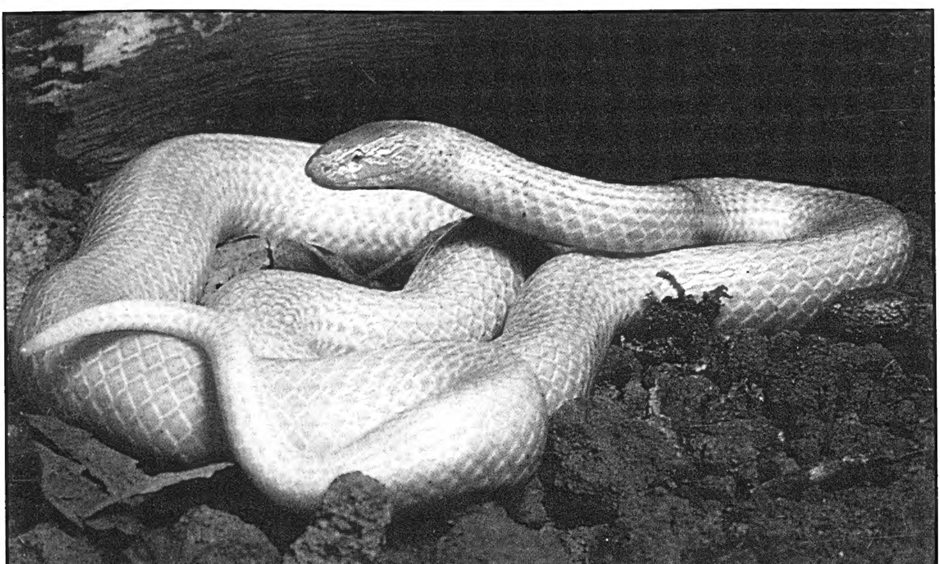
A Copperhead (*Austrelaps superbus*) from King Island. See paper on page1 (photo: B. Munday)



An albino White Crowned Snake (*Cacophis harriettae*) from Brisbane.
See paper on page 31 (photo: B. Cowell)

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SOME OBSERVATIONS ON THE ECOLOGY OF THE COPPERHEAD *AUSTRELAPS SUPERBUS* (SERPENTES: ELAPIDAE) IN TASMANIA

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INTRODUCTION

There is little published data on the ecology of *Austrelaps superbus* on the main island of Tasmania and surrounding offshore islands. Previous literature records are cited as well as the author's collected field notes over a fifteen year period.

The only detailed ecological work on *A.superbus* is that of Shine (1987a) with the author's observations confirming the conclusions of that work.

TAXONOMY

Traditionally, *Austrelaps* has been treated as a monotypic genus, but some recent authors (e.g. Sutherland, 1983; Wilson & Knowles, 1988; Hoser, 1989; Mirtschin & Davis, 1992; Cogger, 1992) have suggested that three separate forms can be separated, following statements made earlier by Rawlinson (1969, 1971) which were based on then unpublished studies. In a posthumous paper Rawlinson (1991) confirms that three separate taxa are involved; *A.superbus, A.ramsayi,* and *A.labialis.*

While *A.superbus* and *A.ramsayi* show overlapping distributions and are very similar ecologically (Shine 1987a); Rawlinson (1991) states that *A.ramsayi* is restricted to higher altitudes and that the two forms have not been collected syntopically.

Read & Bedford (1991) report electrophoretic studies that clearly validate *A.labialis* as a distinct form from either *A.superbus* or *A.ramsayi.*

A.superbus is the only form occurring in Tasmania.

MORPHOLOGY

Dorsal colourations among Tasmanian *A.superbus* are variable. Typically Tasmanian adults are blackish dorsally with reddish or orange dorsolateral scales. Some specimens are bronzy brown or coppery orange over the entire dorsal surface. Melanotic specimens are occasionally encountered. The author has examined a Frankford specimen, jet black dorsally with bluish grey dorsolateral scales, and a greyish black ventral surface. Mackay (1955) records a similar specimen from Fisher Island in the Furneaux Group.

An unusual population occurs on the plateau-like summit of the geological feature known as The Nut at Stanley on Tasmania's north west coast, with adults being a uniform tan brown with creamy yellow dorsoventral scales.

Ventral colouration is usually white, cream or yellow anteriorally fading to greyish towards the vent. Some specimens display a reddish tinge while others have orange ventrals.

Typically anterior ventral colouration extends all the way up to the lower half of the supralabials. The upper half of the supralabials reflect the head colouration, usually various shades of brown. Supralabial margins are indistinctly defined and edged with white, yellowish or tan. In some specimens with dark brown heads, the supralabials are completely brown with barely discernible margins.

All Tasmanian and King Island specimens examined by the author displayed a lighter head colouration than the rest of the dorsal surface.

A lighter (on dark specimens) or darker (on pale specimens) nuchal bar and narrow vertebral stripe may be present on juveniles and small adults but infrequently persists onto large, mature specimens.

DISTRIBUTION AND HABITAT

A.superbus has a wide but discontinuous distribution in Tasmania, mainly in the drier eastern half of the state, from heathland and open scrub bordering marshes and lagoons at sea level, to shallow highland lakes and lagoons above 1000m. In the cooler, higher rainfall, densely forested west and south west *A.superbus* is mainly coastal in distribution; although Sharland (1962) records *A.superbus* inhabiting buttongrass plains in western Tasmania. *A.superbus* probably occurs all the way down the west coast of Tasmania with Green (1984) recording a specimen at Ordnance Point.

Swain (1972) and White (1985) express surprise that there are no records of *A.superbus* from south west Tasmania. White (1985) suggests specimens may have been sighted but were erroneously identified as tiger snakes, *Notechis scutatus*. Confirmation for the occurrence of *A.superbus* in south west Tasmania is provided by Collins (1991) who pictures an unusual melanotic specimen but erroneously identifies it as *N.scutatus*.

A.superbus occurs on a number of Tasmania's offshore islands, with Green & Rainbird (1993) listing all known populations. Green (1969) additionally records the sighting of a specimen on a small, unnamed island off Mt Chappell Island in the Furneaux Group.

In Tasmania, *A.superbus* populations are concentrated around low lying swamps, marshes, lagoons and river flood plains and surrounding grassland and open scrub where their principal prey (frogs and lizards) are abundant. Population densities in suitable habitat can be very high. Norton (pers. comm.) reports capturing over 90 specimens in two days at Lagoon of Islands in Tasmania's central highlands.

The author has never encountered *A.superbus* far from permanent water bodies and never in closed forest of any type.

A.superbus has adapted to habitat alteration in Tasmania with small but dense populations occurring around cities, towns and throughout rural areas. In some areas of rural Tasmania where natural habitat destruction has been complete with grazing and cropping having been established for over 100 years, *A.superbus* is the only snake present with populations persisting around dams, natural soaks and drainage ditches meandering through paddocks and along the verges of country roads. While significant populations have declined or been completely destroyed through the drainage of many of the state's large lagoons it is probable that the overall distribution of *A.superbus* has increased since the arrival of Europeans due to clearing of closed forests and installation of dams and drainage ditches.

Various authors (Lord, 1918; Sharland, 1962; Rawlinson, 1965, 1974; Hewer & Mollison, 1974; Green, 1984; White, 1985) describe similar habitat preferences for Tasmanian *A.superbus*.

Mainland populations of *A.superbus* are also concentrated around low lying water bodies (Waite, 1929; Rawlinson, 1965; Garnet, 1972; Stackhouse, 1972; Worrell, 1970, 1972; Sutherland, 1983; Schwaner, 1985; Mirtschin & Davis, 1992; Wilson & Knowles, 1988; Gow, 1989; Hoser, 1989; Weigel, 1990; Ehmann, 1992; Cogger, 1992).

The author has recorded *A.superbus* living under logs, individual boulders, rock piles, sheets of roofing iron, stumps and in disused rodent and rabbit burrows. The majority of such homesites were situated on the perimeter of swamps and lagoons and never more than one hundred metres from water. Shine (1977c) found the same for the highlands copperhead, *A.ramsayi* (identified as *A.superbus* in Shine's earlier works) in the Armidale region of NSW.

Most commonly however, the author has found *A.superbus* to shelter in dense vegetation around the perimeter of water bodies. Large, dense clumps of buttongrass, *Juncus* spp appear to be particularly favoured. Numerous authors (Sharland, 1962; Worrell, 1970, 1972; Garnet, 1972; Stackhouse, 1972; Wilson & Knowles, 1988; Gow, 1989; Hoser, 1989; Ehmann, 1992) also record buttongrass clumps as homesites. The author has also recorded *A.superbus* living

among clumps of cutting grass, *Carex* spp and in dense gorse bushes, *Ulex europeaus* growing around margins of marshes.

On several occasions the author has recorded sub-adult *A.superbus* utilising yabby burrows (Crustacea: *Engaeus* sp.) in damp earth around marshes as homesites. One specimen was observed basking beside the entrance to a burrow and retreating into it on two separate occasions during the course of a day. The author has recorded *A.superbus* utilising the nesting burrows of the short tailed shearwater (muttonbird) *Puffinus tenuirostris* on The Nut at Stanley on Tasmania's north west coast and on King Island. Worrell (1958) and Green (1969) also record *A.superbus* utilising *P.tenuirostris* burrows on Bass Strait Islands.

In the author's experience Tasmanian *A.superbus* overwinter in shallow hibernacula close to water. On one occasion, two adults were discovered in a paddock adjacent to a marsh, one under a sheet of roofing iron, the other under a discarded tractor tyre. Spencer (pers. comm.) reports a specimen overwintering in a pile of hay bales in a paddock, and Goss (pers. comm.) reports adults under large rocks, logs and amongst dense vegetation during land clearing operations. Shine (1979) discovered that highland copperheads, *A.ramsayi* overwintered singly in shallow hibernacula on slightly raised ground no more than 100m from water.

No detailed data exists for activity ranges of *A.superbus* but there is no reason to suggest that they do not display similar activity ranges to other large elapids (Shine, 1987b; Fearn, 1993), including the ecologically similar *A.ramsayi* (Shine, 1979).

Shine (1987a) discovered that male *A.superbus* are more numerous in museum collections than females and postulated that this phenomenon was a result of overproduction of males at birth or differential behaviour resulting in greater numbers of males being exposed to human culling. The author favours the latter explanation. In late summer/autumn (February/March) Tasmanian and King Island male *A.superbus* become sexually active and appear to move large distances which results in a sudden and marked increase in road kills and encounters with humans.

SIZE RANGE AND GROWTH

Average length of *A.superbus* encountered in Tasmania varies with locality. Average adult lengths of populations close to urban centres that are exposed to high human and domestic animal (cats, dogs) culling pressure and habitat disturbance, generally range from 0.6m to 1m in total length. In rural habitats, particularly around marshes and lagoons, specimens typically range from 1 to 1.38m in total length. The most spectacular populations examined by the author in terms of average length and weight encountered were all concentrated around well vegetated, isolated dams in grazing country on private land.

Stackhouse (1972), Worrell (1972) and Sharland (1962) give a maximum length of 1.53m for Tasmanian specimens. Maximum length is however at least 1.83m (Smith, 1909; Munday, pers. comm.; pers. obs.).

Similar maximum lengths are typical for Tasmania's larger offshore islands. The author has examined the preserved remains of a male King Island *A.superbus*, 1.83m in total length with a girth of 28cm. Such a snake would weigh in the vicinity of 3 kg. Ellis (pers. comm.) also records 1.83m specimens on King Island.

Wilson & Knowles (1988) and Ehmann (1992) imply genetic differences between King and Flinders Island populations and those of Tasmania and the mainland that result in larger average and maximal body sizes. Field work on King Island in February 1992 failed to discover any evidence for selective or adaptive pressures or advantages for larger body size. Average size of specimens encountered (Table 1) was larger than most Tasmanian or mainland populations (pers. obs.; Shine, 1987a) but appeared to be due to: (1) continuity of habitat; (2) abundant prey resource; (3) low human population, producing maximal growth rates, greater survivability and stable populations of large, mature snakes.

Average and maximal sizes of mainland *A.superbus* also appear to be variable (and also probably depend on locality) but fall within the range of Tasmanian and King Island specimens (Waite, 1929; Kinghorn, 1956; Mitchell, 1961; Rawlinson, 1965; Worrell, 1970, 1972; Garnet, 1972; Stackhouse, 1972; Mirtschin & Davis, 1987, 1992; Cogger, 1992; Sutherland, 1982, 1983; Schwaner, 1985; Shine, 1987a; Wilson & Knowles, 1988; Gow, 1989; Hoser, 1989; Weigel, 1990; Ehmann, 1992).

Shine (1987a) records that male *A.superbus* grow larger than females. The author's observations for Tasmanian and King Island *A.superbus* (Table 1) are consistent with those observations. Shine (1978ab), and Shine & Allen (1980) conclude that larger male size relative to female size is an adaptation to intrasexual competition between males. Male-male combat is well documented for mainland *A.superbus* (Shine & Allen, 1980; Shine, 1987a, 1991; Wilson & Knowles, 1988; Mirtschin & Davis, 1992; Ehmann, 1992). Tasmanian *A.superbus* also exhibit male-male combat (Munday, pers. comm.; Norton, pers. comm.). Male-male combat is also recorded for the highlands copperhead, *A.ramsayi* (Shine, 1987a; Lintermans, 1992).

The smallest gravid female examined by the author was 620mm SVL and contained 10 ova. The smallest sexually mature Tasmanian female examined by Shine (1987a) was 617mm SVL. However sexual maturity is attained at considerably smaller body sizes. Dudley (pers. comm.) captured a specimen 595mm SVL (post birth weight 190g) that gave birth to 12 neonates, 200mm long and averaging 4g in weight. Munday (pers. comm.) captured two gravid females 600mm SVL, weight 150g and 540mm SVL, weight 150g. The former specimen contained 6 ova, the latter 12 ova. Males appear to mature at similar body sizes (Shine, 1987a).

It would appear that Tasmanian *A.superbus* are capable of attaining sexual maturity within their second year. Shine (1987a) records highlands copperheads, *A.ramsayi* attaining sexual maturity at two years of age.

REPRODUCTION

In the author's experience, sexual activity for Tasmanian *A.superbus* occurs in late summer/autumn (February/March). Captive specimens exhibited courtship and sexual behaviour at this time and as recorded earlier there is a marked increase in activity of wild males in the same period.

Shine (1977a) observed autumn sexual activity in *A.ramsayi* but on the basis of oviducts of spring collected females containing abundant spermatozoa, believes sexual activity also occurs in spring. Shine & Allen (1980) record spring (September/October) male-male combat for Victorian *A.superbus* which also indicates sexual activity in spring. Various authors record different mating times for *Austrelaps*. Kellaway & Eades (1929) record autumn. Lintermans (1992) records February. Wilson & Knowles (1988) and Ehmann (1992) record spring and autumn. Hoser (1989) and Mirtschin & Davis (1992) record spring. Further research may reveal spring matings in Tasmanian *A.superbus*.

Sexually active male Tasmanian *A.superbus* are extremely excitable and vigorous in their attempts at copulation. Females are rapidly approached with the male then moving along the female's dorsal surface with his jaws pressed firmly into the back of the female. One male repeatedly gave the female gentle bites on the flanks and also took the female's neck in his mouth and attempted to hold on. The female displayed little alarm and simply attempted to crawl away. Once the male's head was aligned with the female's, he commenced rhythmic twitching of the posterior two thirds of his body with the base of the tail and vent twisted down and around, aligned with the female's vent. The rhythmic twitching intensified over several minutes until in a violent motion the male attempted to raise the female's vent area by dragging the base of his tail and vent area forward. This behaviour persisted for several hours at a time, and actual copulation was not observed.

Table 1 Lengths and weights of field caught sample of King Island ***A.superbus***

Number	Snout Vent Length (mm)	Tail Length (mm)	Weight (g)
Males			
1	1105	217	1300
2	820	170	480
3	825	180	500
4	1240	250	1100
5	1120	218	800
6	895	180	520
7	1240	200	950
8	1260	240	1250
9	1100	220	950
10	1050	210	850
11	1000	203	1050
12	1110	200	1050
13	1310	235	850
14	1170	230	1150
15	1180	210	1200
16	1080	205	650
17	1030	200	1050
18	1250	250	1050
19	1230	230	1050
20	460	145	150
Mean	1073.7	209.6	897.5
s.d.	196.2	26.2	292.7
Range	460-1310	145-250	480-1300
Females			
1	725	146	180
2	720	145	200
3	1090	180	1050
4	1100	215	750
5	1100	220	750
6	770	170	300
7	1100	200	1400
8	910	185	100
9	750	165	200
Mean	918.3	180.7	647.8
s.d.	168.5	25.7	423.4
Range	720-1100	145-220	180-1400

Sexually active captive males refused food. This behaviour has also been recorded for tiger snakes *Notechis scutatus* (Bush, 1983; Fearn, 1993); and spotted black snakes *Pseudechis guttatus* (Sambono, pers. comm.). Shine (1987a) records reduced food intake for gravid females.

Shine (1987a) records that females do not reproduce every year and this is consistent with field caught samples of Tasmanian and King Island specimens examined by the author.

In the author's experience, Tasmanian *A.superbus* mate in late summer followed by ovulation in spring and parturition in the late summer of the following season. Shine (1987a) also records this behaviour for *A.superbus*. Rawlinson (1974) records parturition from February to May for Tasmanian *A.superbus*. *A.ramsayi* displays similar behaviour (Shine, 1977a, 1977b, 1987a).

Shine (1987a) found clutch size to be related to maternal body size for *A.superbus* and *A.ramsayi*. The author has found the same to be true for Tasmanian *A.superbus*. Typical clutch sizes are 10 to 15 with the lowest being 6 for a 600mm SVL female (Munday, pers. comm.) and the largest clutch being 26 for a 1213mm SVL female. Tasmanian neonates range from 180 to 200mm in total length, and are typically 4g in weight with a range of 3 to 4.5g.

PREY

The author has recorded prey species consumed by *A.superbus* from road and human killed specimens, and by palpation of living snakes. Prey records were gathered from widely separated populations mainly in the eastern half of Tasmania from lagoons and heathland at sea level, to shallow lakes and lagoons in the central highlands of the state. Additional records were gathered in the vicinity of Stanley on the north west coast and from King Island, western Bass Strait. These are presented in Table 2.

Table 2 Prey Records for Tasmanian and King Island *A.superbus*

Prey	No. of Records	Age/Size of Prey
LIZARDS		
Niveoscincus metallica	18	Adults
N.ocellata	1	Adult
N.pretiosa	9	Adults
Pseudemoia duperreyi	3	Adults
P.entrecasteauxii	6	Adults
Lampropholis delicata	1	Adult
Egernia whitii	3	Adults
Unidentified lizard remains	23	
Total	64	
FROGS		
Litoria ewingii	13	Metamorphlings/Adults
L.raniformis	1	Metamorphling
Crinia signifera	6	Adults
Limnodynastes peronii	10	Metamorphlings
L.tasmaniensis	10	Metamorphlings/Adults
L.dumerilii	1	Adult
Unidentified frog remains	5	
Total	46	
SNAKES		
Drysdalia coronoides	2	Adults
Austrelaps superbus	7	Juveniles/Adults
Total	9	
MAMMALS		
Mus musculus	7	Adults
Rattus rattus	1	Juvenile
R.lutreolus	1	Sub-adult
Perameles gunnii	1	Juvenile
Total	10	

Tasmanian and King Island *A.superbus* are foraging, opportunistic feeders, relatively unselective in respect to prey type or size. Shine (1987a) also found *A.superbus* to be relatively unselective in terms of prey species consumed but speculated on a searching/foraging mode of predation. The author has observed *A.superbus* actively seeking out prey by exploring holes, crevices, grass clumps and probing gaps under rocks and logs.

The major prey species for Tasmanian and King Island *A.superbus* are lizards and frogs (Table 2). Shine (1987a) records the same dietary preferences for mainland and Tasmanian *A.superbus*. Frogs are largely nocturnal and appear to be trapped in their diurnal retreats by foraging snakes.

Shine (1987a) records that the majority of lizards in *A.superbus* diets are diurnal surface active taxa. The author has found the same to be true and that it is sometimes necessary for *A.superbus* to actively pursue skinks in order to capture them. The author has observed this behaviour on two occasions, and in repeatedly lunging and striking at prey the snakes eventually ingested some of the surrounding vegetation along with the skink. In the author's experience, grass, mud and other detritus are often found in *A.superbus* stomachs with prey items.

Basking *A.superbus* will also take advantage of prey passing by. One specimen under observation was basking in a tight coil beside a sheet of roofing iron, and on two occasions, rapidly struck at passing metallic skinks, *Niveoscincus metal*lica but missed. No attempt was made by the snake to pursue the skinks.

Various authors record predominantly lizard and frog diets for all three *Austrelaps* species (Mitchell, 1961; Rawlinson, 1965; Worrell, 1970; Green, 1971; Garnet, 1972; Stackhouse, 1972; Hewer & Mollison, 1974; Shine 1977c, 1987a; Jenkins & Bartell, 1980; Mirtschin & Davis, 1987, 1992; Sutherland, 1982, 1983; Schwaner, 1985; Wilson & Knowles, 1988; Hoser, 1989; Gow, 1989; Read & Bedford, 1991; Ehmann, 1992).

In the author's experience, Tasmanian and King Island *A.superbus* are highly ophiophagus and cannibalistic (Table 2). Most commonly there is considerable disparity between predator and prey with the latter being smaller. However, on one occasion a 1100mm male (total length) had consumed a 700mm male. The ingested snake's tail protruded in the mouth of the predator. Munday (pers. comm.), Norton (pers. comm.) and Hewer & Mollison (1974) also record cannibalism for Tasmanian *A.superbus*. Various authors record ophiophagy and cannibalism for mainland *Austrelaps* (Mitchell, 1961; Worrell, 1970; Garnet, 1972; Stackhouse, 1972; Jenkins & Bartell, 1980; Mirtschin & Davis, 1987; Sutherland, 1982, 1983; Shine, 1987a; Hoser, 1989; Gow, 1989; Ehmann, 1992).

Shine (1987a) records few mammals as prey for *Austrelaps*. Tasmanian *A.superbus* appear to more commonly prey on mammals than mainland populations (Table 2). Tasmanian tiger snakes, *Notechis scutatus* also appear to eat more large endotherms than mainland specimens (Fearn, 1993). Shine (1977c, 1987a) concludes that large prey (mammals) are scarce in most *Austrelaps* habitat on mainland Australia. However in Tasmania, introduced rodents, particularly the house mouse, *Mus musculus* and the black rat, *Rattus rattus* are common over much of the state, particularly in rural habitats. In addition, native mammals that are rare, restricted in distribution or extinct on the mainland (for example the eastern barred bandicoot, *Perameles gunnii*) are still abundant in Tasmania (Strahan, 1983) possibly due to substantially less natural habitat destruction than other mainland states and the absence of introduced predators such as foxes.

Small head size relative to body size limits the size of prey that adult *A.superbus* can successful ingest. Experiments with a captive 1730mm (total length), 3 kg King Island *A.superbus* have revealed an upper size limit of 150g for successful ingestion of black rats, *Rattus rattus*. Other

large elapids such as tiger snakes *Notechis scutatus* of the same total lengths are capable of swallowing rats up to 300g in body weight (Fearn, 1993).

As recorded earlier in this work, an unusual population of *A.superbus* occurs on the plateau-like summit of the volcanic plug known as The Nut at Stanley on Tasmania's north west coast. No permanent water exists on The Nut, and no frogs occur there. Field work on The Nut revealed *A.superbus* to be concentrated in and around the perimeter of several short tailed shearwater (mutton bird), *Puffinus tenuirostris* rookeries. Adult snakes were observed retreating into *P.tenuirostris* burrows on numerous occasions. No evidence could be found that adult *A.superbus* were predating on *P.tenuirostris* hatchlings and it is the author's belief that *A.superbus* is incapable of ingesting hatchling *P.tenuirostris* with a mean weight of 64g (Marchant & Higgins, 1990). Captive experiments with a 1530mm (total length) male *A.superbus* demonstrated an inability to ingest substantially smaller hatchling chickens, typically ranging from 25 to 40g in weight (pers. obs.). The peculiar bulbous shape of hatchling birds present difficulties to the limited swallowing capacity of *A.superbus*. Examination of faecal matter and palpation of stomach contents revealed skinks, mainly *Niveoscincus metallica* and *Egernia whitii* to comprise the diet of *A.superbus* on The Nut.

A.superbus also occurs on a number of small Bass Strait Islands (Green & Rainbird, 1993) where permanent water and frogs are absent. *A.superbus* also inhabits nesting burrows of *P.tenuirostris* on such islands (Worrell, 1958; Green, 1969) with lizards probably comprising the diet in those populations.

Shine (1977c, 1987a) records few examples of invertebrates as prey. Munday (pers. comm.) and Spencer (pers. comm.) have both observed Tasmanian *A.superbus* actively pursuing, capturing and ingesting large, flightless grasshoppers (Orthoptera: Acrididae).

Carrion may also be occasionally consumed. The author removed a large bone fragment from a road killed *A.superbus*. Green (pers. comm.) identified the fragment as part of the limb bone of a small mammal, possibly a bandicoot at least twice the size of an adult black rat, *Rattus rattus*. *A.superbus* is incapable of swallowing such a large prey item and probably consumed the limb of a road or predator killed bandicoot.

Neonate and sub-adult *A.superbus* consume similar prey to adults both in terms of species composition and size of prey. Shine (1987a) also records this behaviour. The author and Munday (pers. comm.) have on numerous occasions, in widely separated populations, observed that neonates and sub-adults appear to be primarily observed on higher ground away from the waters edge where adults congregate and conduct most of their foraging. It is not clear whether this behaviour is in response to skinks being more numerous on higher, drier ground or whether it is a response to avoiding the ophiophagus tendencies of adults. This behaviour may also be in response to rapid cooling and loss of body heat by small snakes foraging in wet and damp vegetation on the perimeter of water bodies. These aspects of *A.superbus* ecology warrant detailed study.

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NOTES ON THE ECOLOGY OF THE DWARF CROWNED SNAKE *(CACOPHIS KREFFTI)* IN NORTHEASTERN NSW

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INTRODUCTION

The Dwarf Crowned Snake (*Cacophis krefftii*) is a small (to 33 cm SVL) secretive, nocturnal elapid snake (Shine, 1980) which occurs in coastal and near-coastal areas from the central coast of NSW to southeastern Queensland (Longmore, 1986). *C.krefftii* is recorded as being cryptozoic and terrestrial (Wilson and Knowles, 1988) and has been reported to consume skinks, lizard eggs, and a blind snake (Shine, 1980).

This note reports the author's observations (except where acknowledged otherwise) on the diet, activity, habitat and microhabitat of *C.krefftii* in northeastern NSW, mainly from the Byron Shire area. The pattern of distribution of *C.krefftii* recorded in this note is not intended to indicate abundance.

HABITAT AND MICROHABITAT

Specimens were observed in diverse coastal and near coastal habitats including Wallum, regenerating "synthetic" forests on former pasture and banana lands, in montane rainforests and in gardens (Table 1).

They were found under flat cover tightly flush with soft underlying soils or leaf litter, actively crossing roads at night, and least commonly, active during daylight in closed canopy forests.

Table 1: *Cacophis krefftii* records for northern NSW

Date	Location	Habitat/Microhabitat
?/?/70	Grafton (2 specimens)	Between sheets of iron; open ironbark forest
?/9/82	Mullumbimby Ck	Active on leaflitter under lantana in closed forest in late morning
4/8/89	Ewingsdale	Under basalt rockpile
1/9/89	Ewingsdale	Under fence post; paddock
14/10/89	Mt Nullum	Under log; regen/open forest
24/12/89	Mullumbimby Ck	Under sheet fibro in garden
8/5/92	Mullumbimby Ck	Under timber in garden
25/6/92	Belongil	Sheet iron in estuarine wetland
15/7/92	Belongil	Sheet iron in estuarine wetland
16/5/93	Mullumbimby Ck	Active in litter over rhyolite scree slope; open forest
?/2/93	Chaelundi S.F. (2 specimens)	Under rock slabs; moist hardwood forest
3/10/93	Mullumbimby Ck	AOR; forest; 2030DST
4/10/93	Mullumbimby Ck	DOR; shrubby paddocks
5/10/93	Mullumbimby Ck	Under sheet fibro in garden
11/12/93	Mullumbimby Ck	Sheet iron in garden 1825DST
?/2/94	Byron Bay	Under rubbish in garden
8/3/94	Mullumbimby Ck	Sheet iron in garden
7/4/94	Dorrigo	AOR; 1975EST; temperate rainforest
27/4/94	Mullumbimby Ck	Under sheet fibro in garden

DST = daylight saving time; EST = eastern standard time;
AOR = alive on road DOR = dead on road

ACTIVITY/DIET

C.krefftí has been described as nocturnal on the basis that "... captive specimens have not been seen to bask, or emerge from cover, during the day" and that "In the field active specimens may be encountered on warm humid evenings" (Shine, 1980). Nocturnality is also recorded by Wilson and Knowles (1988) who further note that "Crowned snakes feed on skinks particularly the diurnal genera *Lampropholis* and *Leiolopisma*. These are probably captured while inactive". This presumed tendency to nocturnal prey-capture of skinks from these two diurnal genera is also noted by Shine (1980); "Since the lizards are almost entirely diurnal and *Cacophis* is nocturnal, the snakes must capture the lizards while the latter are inactive in their night-time retreats". Shine (1980) also notes only nocturnal feeding observed in a captive *C.squamulosus.*

Although the majority of the snakes were encountered in circumstances typical of a nocturnal lifestyle (19 of 21: Table 1), two were active diurnally, suggesting that under certain conditions they may not be strictly nocturnal.

On 11th December 1993 at 1825 (Daylight Saving Time) an adult *C.krefftí* was discovered consuming a skink (probably *Lampropholis delicata*) under a sheet of iron in a garden at Mullumbimby Creek, adjacent to regenerating rainforest. That the skink had only recently been captured was evident by the wriggling tail.

Diurnal feeding in *C.krefftí* was also recorded during Spring 1993 in a garden at Ocean Shores adjacent to closed forest, when an adult *C.krefftí* was found consuming a skink (S. Nelson, pers. comm.).

Most prey capture and feeding in *C.krefftí* and congeners probably takes place at night. However diurnal feeding under shelter may occur more frequently than is reflected by accounts in the literature. The tendency for diurnal skinks to flee under cover when evading predators and other threats, provides an opportunity for ambush-feeding by this and other saurophagous elapids.

The same shelter sites utilised by this species and other cryptozoic elapids are often used as basking and nocturnal shelter sites by prey species (scincids).

An adult *C.krefftí* was observed in what may have been an ambush posture with its head level with the surface of leaflitter adjacent to a piece of timber flush with the soil, under which the remainder of the snake's body was positioned. It is the author's experience that *C.krefftí* and other elapids can be predictably attracted to pieces of flat material placed in appropriate habitat. Such cover appears to offer suitable microhabitat in a tactile sense (*C.krefftí* in common with other small elapids seem to like to be crammed tightly into a crevice). There may also be thermoregulatory and trophic advantages attached to the use of such cover; sheets of iron (rock, bark or fibro) may heat up more quickly than other types of cover (e.g. damp logs, leaflitter), and often shelter skinks.

DIET

The dietary records noted above support previous accounts that skinks are the major prey for this species (Cogger, 1992; Shine, 1980; Wilson and Knowles, 1988). Skinks were also recorded as prey on one other occasion when an adult *C.krefftí* from the Byron Bay area was observed to regurgitate 3 skinks tails (M. Whicker, pers. comm.).

The presence of encysted sparganids (larval tapeworms) in an adult *C.krefftí* found at Mullumbimby Creek on 8/3/94 suggests that frogs are also occasionally taken as prey by this species. Frogs appear to be a vector for this parasite, as sparganids are most often present in snake species which consume frogs (e.g. Common Tree snake *Dendrelaphis punctulatus*).

SYMPATRY WITH *C.SQUAMULOSUS* AND HABITAT PREFERENCES

The Golden Crowned snake *C.squamulosus*, is larger (to 60 cm SVL) than *C.kreffti* and occurs in sympatry with it in certain habitat types in northern New South Wales. In Byron Shire *C.kreffti* appears to persist in developed agricultural regions, while *C.squamulosus* is usually not recorded far from substantial tracts of forest.

C.kreffti has been observed in suburban gardens, along tree belts and in rock walls in pasture, regenerating forest and banana plantations on coastal slopes (e.g. Ewingsdale), and under sheet iron in lowlying estuarine wetland. *C.squamulosus* has not been recorded in these areas by the author.

Sympatry of the two species in Byron Shire appears to begin in the forested foothills, valleys and lower slopes of the Koonyum and Nightcap ranges.

How the two Crowned snakes partition the resources and niches of nocturnal skink-feeding between themselves, *Hemiaspis signata* and *Rhinhoplocephalus nigrescens* is an area of interest. The third *Cacophis* species recorded from NSW, *C.harrietae* has not been observed by the author in this region.

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Figure 1. *Cacophis kreffti* from Byron Bay.

THREE SPECIES OF GOANNA OCCUR IN THE SYDNEY BASIN

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The occurrence of two species of goanna in the Sydney region has been recognised for many years. The Lace Monitor, *Varanus varius* (Shaw, 1790), widely distributed in eastern Australia, was first described from a specimen from the environs of Sydney Harbour, and was one of the first Australian reptiles to be named. The second species, known for many years as *Varanus gouldii* (Gray, 1838), was first recorded with a voucher specimen as early as 1905 (Australian Museum [AM] R3694, Loftus). The distinctive morphology, particularly the melanistic coloration, of the Sydney Basin population of this second species was widely recognised by professional and amateur herpetologists (Worrell, 1963; Schmida, 1985; Griffiths, 1987; Greer, 1989; Hoser, 1989), who commonly referred to the population as "Sydney Gould's" in informal discussions. In their controversial classification, Wells and Wellington (1985) described a specimen of this population from Kuringai Chase National Park as a new species, *Pantherosaurus kuringai*, but gave no indication of morphological differentiation of this species from other members of the *Varanus gouldii* complex to justify their claim. They further noted an Australian Museum record of a member of the *Varanus gouldii* complex from the Cooma district, and suggested that this may represent the same species.

The first published colour photograph of an individual of the Sydney Basin *Varanus gouldii* population (Schmida, 1985) led to its tentative reidentification (Böhme, 1987) as *Varanus rosenbergi* Mertens, 1958, a species previously only known from the southern coastal regions of Western Australia and South Australia. At the same time, and independently of Wells and Wellington's comments on Sydney and Cooma animals, Böhme's conclusions and knowledge of the Sydney Basin populations, several monitors from the Australian Capital Territory were tentatively identified (Georges, 1988) as *Varanus rosenbergi*. In the following year, an isolated population of the same species was reported from north-western Victoria (Robertson *et al.*, 1989). Although no detailed morphological or biochemical analysis of the affinities of the "Sydney Gould's" has yet been published, most recent authors have accepted that this taxon is *Varanus rosenbergi* (Wilson and Knowles, 1988; Cogger, 1992; Ehmann, 1992; Ehmann *et al.*, 1991; King and Green, 1993). Certainly, the population closely agrees in all morphological respects with the redescription of *V.rosenbergi* by Storr (1980). Of the variable characters given by Storr (1980), the "Sydney Gould's" (based on Australian Museum specimens) has snout-vent length (SVL) 11.5-50.2 cm ($\bar{x}$ = 33.2 mm; n = 15), forelimb length (%SVL) 26.3-33.0 ($\bar{x}$ = 29.4; n = 13), hindlimb length (%SVL) 37.8-43.4 ($\bar{x}$ = 41.3; n = 13), tail length (%SVL) 136.6-169.0 ($\bar{x}$ = 152.5; n = 11), mid-body scale rows 182-207 ($\bar{x}$ = 196.1; n = 15) and lamellae below fourth toe 24-29 ($\bar{x}$ = 25.7; n = 29). The three smallest individuals (SVL 11.5-12.3 cm) are apparently hatchlings, while the only specimen with SVL greater than 47 cm is the southernmost.

A New South Wales distribution map for *V.rosenbergi* has been published by Swan (1990), who reports the southern limits of the distribution as Canberra and the northern limits at Wondabyne, just north of the Hawkesbury River, although there are more recent and reidentified older Australian Museum records from a little way further north (AM R123331, 19km N Kulnura on Wollombi Rd) and much further south (AM R95810, "Cundumbul", N of Cooma; presumably the Cooma record cited by Wells and Wellington, 1985) (Fig. 1).

Varanus rosenbergi populations have been claimed to be in decline or extinct in several parts of the Sydney Basin, including the Blue Mountains Plateau and foothills, the Kanangra-Boyd Plateau and the upper Cox's River drainage (Wells & Wellington, 1988a-d), and the species is currently listed as "Vulnerable and Rare" in Schedule 12 of the New South Wales National Parks and Wildlife Act.

Given the special status afforded to the Sydney Basin *V.rosenbergi* and its previously confused nomenclatural history, it is worth documenting the recent confirmation of the occurrence of a third, morphologically similar species of goanna from the Hunter Valley, close to the northern extremity of the distribution of *V.rosenbergi.* This species is morphologically similar to specimens from western New South Wales and other parts of Australia currently assigned to *Varanus gouldii* (*sensu* Storr, 1980; Swan, 1990), and is here regarded as that species, although there are nomenclatural problems associated with application of that name (Böhme, 1991) and no recent revision has been undertaken of geographic variation within the taxon.

A hatchling (Australian Museum R143562; SVL 13.7 cm; Fig. 2) was collected by R. Wells and C.R. Wellington from a burrow in sandy soil below a sandstone rock on an east facing sandstone ridge at 8.9 km S Garland Valley on the Putty Rd (32°45'S 150°55'E) on 25 April 1983. On 19 December 1988, Mr T. Hawkes, accompanied by the author, excavated a subadult from a short

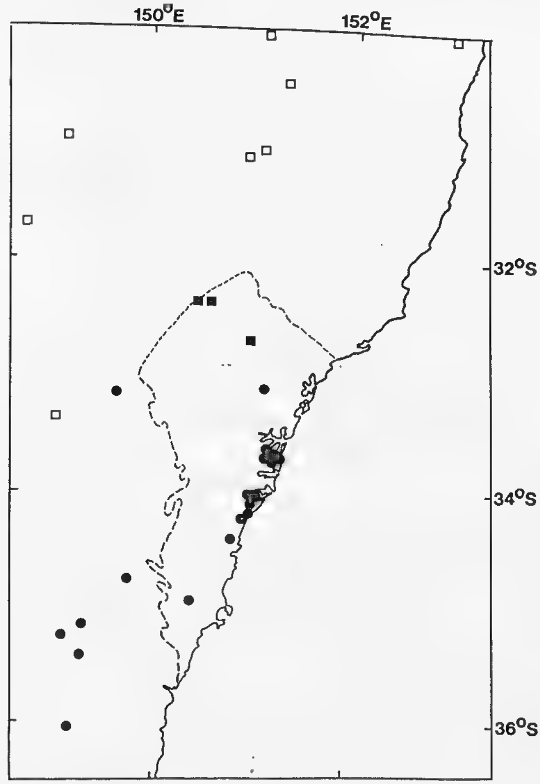

Fig. 1. Distribution of *V.rosenbergi* (dots) and *V.gouldii* (squares) in the Sydney Basin and adjacent parts of eastern New South Wales, based on Australian Museum records, literature records (Georges, 1988; Ehmann *et al.*, 1991 and photograph caption on cover of Herpetofauna 21(1)) and observations reported in this paper. Open squares are previously known records of *V.gouldii*; closed squares are the three new records reported in this paper. Dashed line indicates limits of Sydney Basin, based on Bembrick *et al.* (1980).North-western limit (Mt Coricudgy anticline) approximate.

burrow on top of a sandstone ridge in *Callitris*-eucalypt woodland at 1.7 km E Sandy Hollow - Baerami Rd via Old Yarrawa Rd (32°23'S 150°31'E). This specimen was released at the site of capture. On the following day, we found an adult female *V.gouldii* (AM R130732; SVL 31.8 cm) dead on the road at 3.5 km W Baerami (Mt Dangar Rd intersection) via Bylong Rd (32°23'S 150°26'E). This individual had numerous deeply embedded plant spines around the limbs and this may have played a part in the animal's death by restricting mobility. Despite this, it was apparently in good condition.

There are three additional specimens of *V.gouldii* from the Sydney region in the Australian Museum collection, all morphologically typical of the species in New South Wales. The earliest, R3888, Beecroft, presented by A. Antrobus and registered in 1907, is a pale coloured adult, though discoloured with long preservation. The second, R28540, Macquarie University, presented by the Biology Dept in 1969, is a pale coloured large adult. The third, R68815, Wondabyne, presented by G. Rollo *via* R. Wells, collected in 1967, is a very emaciated dark coloured adult, suggesting a long period in captivity. In the absence of any confirmatory evidence for the occurrence of *V.gouldii* in the suburbs of Sydney or the Gosford region, I consider at least the latter two and probably all three records to be spurious, based either on escapees or misapplication of locality to captive specimens.

Although widespread and common in western New South Wales, *V.gouldii* is sparsely distributed along the coast and ranges. Outside of the three Sydney Basin records, there are only eight specimen-based records from east of a line through the Yetman district, Gilgandra, Cowra and Wagga: one from the vicinity of Orange (AM R28496, Bald Hill, Canobolas State Forest), and seven from the New England tableland and hinterland (AM R9510, Kootingal; R59736, 12 mi N Bundarra; R59737, 1 mi S Diehard Ck on old Gwydir Hwy; R68817, Tamworth district; R73774, 4 mi from Yarrowyck on Kingston Rd; R96718, Flaggy Ck, N of Glenreagh; R112855, 27.8 km S Gwydir Hwy via Terrie Hie Hie-Gravesend Rd). Apart from the Sydney Basin records, only the Diehard Ck and Flaggy Ck localities lie on or to the east of the Great Dividing Range. Swan (1990) maps two other eastern New South Wales localities for *V.gouldii*. One, based on AM R21614, 2 mi E Goulburn, is based on a misidentified *V.rosenbergi*, while the second is

Fig. 2. Neonate *Varanus gouldii* from 8.9 km S Garland Valley.

based on AM R67345-48, ripped from rabbit warrens at Kinchela (G. Swan, pers. comm.), then believed to be the coastal town, but now considered more likely to be the inland station property at 30°25'S 146°00'E.

The three northern Sydney Basin *V.gouldii* records are over 115 km NE, 150 km SSW and 185 km ESE of the nearest previous records of *Varanus gouldii* in New South Wales, and extend the distribution of this species to within 48 km of the range of New South Wales *Varanus rosenbergi*. Much of the intervening country, in the Hunter Range, is poorly accessible, and further work is needed to determine if the two species occur in sympatry. A second region where the two species approach is to the west of the Sydney Basin, where the nearest *V.gouldii* (AM R28496, see above) is less than 65 km south-west from *V.rosenbergi* (AM R107267, The Forge, 20 mi N Bathurst).

The occurrence of *Varanus gouldii* in the Hunter Valley is yet another example of a predominantly arid or Western Slopes species entering the northern Sydney Basin through this corridor. Other examples are *Oedura robusta, Delma plebeia, Carlia tetradactyla, Egernia striolata, Hemiergis decresiensis, Lerista bougainvilli, Ramphotyphlops wiedii* and *Pseudechis guttatus* (distributions based on Swan, 1990).

The three species of goanna in the Sydney Basin may be differentiated by the following key:

1. A row of enlarged tubercles forming a comb-like ridge on the ventrocaudal margin of the fourth toe; a single enlarged pale scale dorsally bordering the claw on the fourth toe; distal portion of tail with broad alternating dark and pale bands......................... *V.varius.*

No comb-like ridge below fourth toe; several pale scales dorsally bordering claw on fourth toe; distal portion of tail without broad bands (bands narrow if present) 2

2. Coloration predominantly yellow (dorsally melanised in some adults - in these the pale markings take the form of spots and blotches); dark markings on nape longitudinally oriented; body venter yellow with scattered small dark spots; tail banded proximally, unbanded (usually bright to dusky yellow) distally............................ *V.gouldii*

Coloration predominantly dark; dark markings on nape obliquely to transversely oriented; body venter with dark marbling, ocelli or bands; distal portion of tail, like remainder of tail, with narrow alternating dark and pale bands.................... *V.rosenbergi*

SPECIMENS EXAMINED (all in Australian Museum)

V.rosenbergi

New South Wales population (n = 18) : R3694, R13077, R15965, R21614, R49193, R86871-72, R95810, R103531, R107267, R111030 (cleared and stained osteological preparation), R116992 (holotype of *Pantherosaurus kuringai*), R120944, R123331, R123333, R127397-98, R132056.

South Australian population (n = 8) : R7126, R19029-31, R19136, R19723, R81556, R131191.

Western Australian population (n = 8) : R7634, R11109, R102312, R105600, R105608, R105595 (head only), R119494, R133750.

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NATURAL HISTORY OF THE WESTERN TIGER SNAKE: CAPTIVE REPRODUCTIVE POTENTIAL AND LONGEVITY

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Between 1976 and 1987 I worked as a windmill mechanic on the Esperance sandplain. During that time I observed the local indigenous snakes both in the wild and in captivity. The female tiger snake which is the subject of this article was one of my study snakes reported on in Bush (1983).

The western tiger snake, *Notechis scutatus occidentalis* is one of the most common large elapids on the southern coast of Western Australia. It shows a preference for the periphery of poorly drained swampy habitats and may also be found along rivers. It is generally a frog eater but will also take birds. Occasionally I have it around hay stacks feeding on mice, suggesting it does forage away from its preferred habitat.

To illustrate the local abundance of *N.scutatus,* during a one hour visit to the Coomalbidgup Swamp (33°43'S, 121°22'E) in May 1990 I observed 36 individual tiger snakes and 12 crowned snakes, *Drysdalia coronata*, a small elapid commonly found in similar habitats.

Published longevity records for Australian snakes are all but nonexistent, and I can find no records on the reproductive history of an individual snake. The following record involves a snake born and kept continuously in captivity. A study of this kind in the wild would be a massive undertaking and may span many years. I suggest here that this study only presents reproductive potential under optimum conditions for this species, and may not relate to the natural situation.

A female *Notechis scutatus occidentalis* born in captivity in April 1979 from wild parents collected at Lort River, WA in 33°44'S, 121°17'E was introduced to conspecific males and females at age 30 months. It was housed in the same enclosure, an open corrugated iron "pit", until May 1987 before being housed separately in a glass-fronted cage with a floor area measuring 60 x 90 centimetres.

Between March 1983 (age 47 months) and June 1987 (age 97 months) it produced five litters (1 per year) numbering in total 136 offspring plus 2 infertile oocytes in the final clutch. The combined mass of offspring was 950.6g. At death (Aug. 1992 and 160 months old) this snake had a snout-vent length (SVL) of 1040mm and weighed 584g. Nineteen months previous this snake was the same length but weighed 715g. The successful breeding of this snake each consecutive year is of particular interest. Fearn (1993) reports biennial reproduction in tiger snakes from the Tasmanian region.

Although she had been housed with several males, both separately and simultaneously, she failed to produce a 6th litter, although unsuccessful attempts at copulation by different males had been observed on several occasions since the 5th litter. This may be a result of attaining an age when ovulation ceases. Or alternatively the change of environment from open pit to enclosed cage may have triggered a halt in this. I am of the opinion that this female had attained an age when it was reproductively senile, suggesting under optimum conditions in the wild a female may produce a maximum of five consecutive clutches, although in the wild this many consecutive clutches from a single female would be unlikely. Data on female SVL and mass relative to litter, date of birth, litter size (N), neonate SVL and weight (W) and reproductive effort (RE) are included in Table 1. All measurements of length are in millimetres and weight in grams. Means are in brackets. RE is presented as a percentage - total offspring weight to female weight with measurements recorded immediately after birth.

Table 1. Data on female *Notechis scutatus occidentalis* and 5 clutches of offspring produced in consecutive years from 1983. First clutch at 47 months old.

Date	11-03-83	09-04-84	08-04-85	30-04-86	08-06-87	Jan 91
SVL	763	886	948	991	1018	1040
W	400	503	560	613	634	715
N	20	32	31	35	18+2	
Juv. SVL	223-237 (229)	202-222 (211)	194-216 (208)	185-221 (212)	188-210 (200)	
Juv. W	8.1-9.2 (8.6)	5.9-7.2 (6.6)	5.2-7.0 (6.5)	4.7-7.8 (7.0)	5.6-6.8 (6.1)	
RE	43.2	41.9	36.0	40.0	19.2	

SVL - Snout vent length (mm)

W - Weight (gm)

N - Number of offspring in respective clutch

RE - Reproductive effort as a % of females' weight immediately after birth.

DISCUSSION

Shine (1991) in a summary of his work states that the number of offspring correlates with female body size. This is partly the case here: 1st litter 20, 2nd 32, 3rd 31, 4th 35, however, the 5th litter regressed both in number (20) and size. Mean offspring weight of 4th 6.97g and 5th 6.1g. In present study RE decreased generally with age (except 4th) consistent with Shine's findings. Reproductive data presented by Bush (1992) suggests this is also the case in the small elapid *Echiopsis curtus*, while the reverse occurs in another small elapid *Drysdalia coronata*.

The size at birth of Western Australian *N.scutatus* are larger than some populations in eastern Australia. Shine (1978) during a study at 2 sites in New South Wales found mean SVL and mass in neonates to be 189.4mm and 4.59g versus 211.9mm and 6.96g in present study. This difference may be exaggerated by including the large offspring from my females' first litter (mean SVL 228.8mm, W 8.63g), while Shine's data may be from a single litter from one snake. However, excluding my first litter from calculations, birth sizes in WA *scutatus* still appear larger. Shine (1977) was of the opinion that the snakes in his study area, which was the same as for his 1978 paper, were generally smaller than elsewhere. WA *scutatus* are smaller as adults than the population he studied, maximum SVL 1020mm (Storr, 1982) v. 1200mm (Shine, 1978). The larger neonate size recorded here is not only consistent with his findings that elapid snakes in which the adults are smaller have proportionately larger young than do larger species, but this also is the case intraspecifically between populations of different adult size. My study snake is definitely heavier than comparable length representatives from Uralla, eastern Australia (Shine & Bull, 1977), but this is probably a result of life in captivity.

Shine also found a high percentage of infertile oocytes (9.2%) in his study population of *scutatus* compared to only 1.4% of the total in this captive female. Gravid females collected from the same site as the parents of the snake reported here and retained until parturition passed very few infertile ova (pers. obs.). However I have two records (Bush, loc cit) of small elapids passing

large numbers of infertile oocytes (57% in *D.coronata* and 43% in *E.curtus*). Maybe, if a female is carrying insufficient fat-bodies to sustain the available ova and food continues to be scarce, some ova are not fertilised or suffer early embryonic death. Little resorption of yolk is evident (Shine & Bull, 1977) however, I get the impression, if conditions are bad, that the females' body tissue may sustain the embryos to full-term leading to death of the female after parturition. I have collected female *scutatus* in the Esperance area of WA in May and June that appear so emaciated that I doubt they could recoup condition to survive through to the following spring. Maybe if fertilisation of some of the oocytes is aborted then a portion of a potentially larger clutch survives. The alternative, when food resources are scarce, is the demise of not only the entire clutch but the female as well. I remember a large obviously gravid "skin and bone" female I collected at Lort River. She aborted, passing dead, partly developed embryos and then died within the week. I experienced something similar in a Master's snake, *Drysdalia mastersii*. It gave birth to two healthy offspring and one dead, partly developed embryo, but went on to survive the ordeal.

The few infertile oocytes recorded here in western *N.scutatus* may be the result of the small sample size involved. If there is a dichotomy in the frequency of infertile oocytes between western and eastern populations then this divergence in reproductive physiology warrants further investigation. It may just be that in western populations there is considerably more prey or less competition from other similar sized predators for the available food resources. The problems mentioned above may be totally unrelated to this.

SUMMARY

Captive life span	13 years, 4 months
Total offspring	136
Maximum weight attained	715g
Maximum post-parturition weight	634g
Weight at death	584g
SVL at death	1040mm
Number of sloughs during life	32

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ROUND WORMS (*OPHIDASCARIS ROBERTSII*) IN PYTHONS THEIR TREATMENT AND SOME POTENTIAL PROBLEMS

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ABSTRACT

Following the death of a Diamond Python (*Morelia spilota spilota*) to round worms (*Ophidascaris robertsii*), despite treatment with a recommended anthelminthic over several years, a switch to a new treatment resulted in the death of two Black Headed pythons (*Aspidites melanocephalus*). It appears the method of application may have a significant effect on the toxicity to reptiles.

THE FACTS

In December 1993 a Diamond Python in my collection died due to a severe round worm infestation. It was an adult male 1.7m long weighing 1.5kg. It had been in my possession for 3 years. The snake had been wormed on four different occasions but not during the year preceding death, and had been fed almost entirely on frozen rates and mice. The worming treatment that had been used on this snake was Canex 2.5 (active ingredient Pyrantel Embonate), administered via a food item at the dose rate of 1 tablet per 2.5kg body weight (approximately 2/3 of a tablet).

Prior to showing signs of being ill the animal had appeared healthy although it had eaten very little over the previous nine months. I had been absent during April and May and the person looking after the snake could not get it to feed. On my return it was winter and the snake refused to eat. After winter it commenced mating but still refused to eat. This had been the normal practice for this animal in the previous two seasons. In November, after two months of mating the snake commenced eating ravenously for a few weeks but then suddenly stopped. This refusal to eat was followed by a rapid loss in weight, lethargy and constant passing of urates and fluid. The snake continued to deteriorate and I sought veterinary advice. Faecal analysis demonstrated round worm infestation.

The treatment given was a subcutaneous injection of *Ivermectin at a dose rate of 0.02ml/kg plus 15ml of Hartmans solution. Over the next few days the snake continued to deteriorate. There was a constant and smelly fluid loss from the vent. Three days later the snake died. A post-mortem was performed confirming the diagnosis. The stomach and intestines were full of round worms which had perforated the stomach wall in places causing abscessation. The time from the onset of the symptoms to death was approximately 4 weeks.

As a result of my personal doubt about the efficacy of Canex 2.5 as an helminthic for round worm in reptiles it was decided to worm all my adult snakes with an alternative treatment. After reading the available literature I decided on Panacur 2.5 (active ingredient Mebendazole) at a dose rate of 2ml/kg. This was administered to all my adult snakes except for two Black Headed pythons, by injecting it into a food item. No untoward consequences were observed and at least partial success obtained, as evidenced by the presence of dead worms in the faeces of some of the treated animals.

The success of a worming treatment cannot be measured by the presence of dead worms in the faeces as the worms can be absorbed by the digestion process after their death. The absence of dead worms in the faeces does not indicate that worms were not present or that the treatment was not effective. A test on a faecal sample is required to confirm the presence of internal parasites.

*Ivomec (Ivermectin 10mg/ml) - Dose = 0.2mg/kg = 0.02ml/kg NB: Ivomec liquid for sheep can be diluted with sterile water 0.8mg/ml but is only available in minimum quantity of 5 litres. Many city vets do not keep it in stock.

The two Black Headed pythons refused to eat so the Panacur was administered, as often recommended, by tubing it directly into the stomach. Two days after treatment both animals began to hold their head in a strange position, this progressed to twisting and contorting their whole body if they were touched. The head would hang limp if they were picked up. Both snakes were examined by a vet who diagnosed a reaction to the Panacur 2.5. Treatment given was a daily injection of 15ml of Hartmans solution to try to perfuse the vital organs as much as possible. The twisting and contorting became much worse and were interpreted as classic pain reactions. Eight days after administering the Panacur, the first specimen, a male of 1.5m and 1.35kg died. The second specimen, a male of 1.6m and 1.5kg died a further two days later.

DISCUSSION

Several explanations have been offered as to the possible cause of the death of the Black Headed pythons. The first is the possibility that I inadvertently administered an excessive amount of Panacur. This can be ruled out as the volume of the syringe used did not lend itself to administering an overdose.

Another is that I was given Panacur 10 instead of Panacur 2.5 which would result in an overdose at the dose rate given. To check this I visited the Veterinarian who sold me the Panacur (in an unlabelled bottle). I was shown the container that the sample was taken from and it was factory labelled Panacur 2.5. They do not keep Panacur 10 on the premises. It is believed that the correct amount of the correct strength Panacur was administered.

It was also suggested that the tubing process may have damaged the gut by either perforation or irritation to the lining leading to haemorrhage etc. This can also be ruled out as a post-mortem was performed on one of the specimens which showed no internal damage.

The survival of the animals treated with Panacur via a food item compared to those treated by tubing directly into the stomach can possibly be put down to absorption rate. The Panacur in the food item will be slowly released over a period of time, possibly as long as a week, while that tubed directly into an empty stomach will be absorbed very quickly, effectively resulting in an overdose. It is not believed that Black Headed pythons are more sensitive to Panacur than other reptiles as a third specimen of this species was treated via the food item with no apparent ill effect.

Several important lessons can be learnt from the above events. Firstly it is important to worm captive reptiles regularly, probably once every six months, particularly if they have come from the wild or have been fed food that may be carrying worms themselves. Having said that, what do you use? I personally now have reservations about the efficacy of Canex 2.5 for use on reptiles and it appears Panacur 2.5 may carry associated risks under certain methods of use. The vet that treated my snakes currently uses Ivermectin injections and limited studies suggest that it may be very effective in controlling round worm in reptiles with no known side effects.

Whatever you use be very careful with the amounts you administer and if trying a new treatment or method of administering it, try it on one animal first, possibly at a low dose level and observe its reaction for some time before treating your whole collection. The published dose levels listed in the literature are often taken from known effects on mammals and few studies have been carried out on reptiles for most treatments.

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REPTILES AND AMPHIBIANS OF SEVEN MILE BEACH NATIONAL PARK, NSW

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ABSTRACT

A survey of the reptiles and amphibians in Seven Mile Beach National Park (on the NSW South Coast) was conducted between December 1993 and June 1994. A total of 26 species were identified as occurring in the Park. This included seven species of tree frog, two species of ground frog, one species of turtle, one species of dragon, one species of monitor, eight species of skink, one species of python, four species of front-fanged snake, and one species of seasnake. Additional species which may occur in the Park are also noted. Difficulties with the management of the herpetofauna in this small, isolated park are discussed.

INTRODUCTION

Seven Mile Beach National Park (34°47'S 150°46'E) covers an area of 898 hectares of dune, coastal forest and freshwater swamp between Gerroa and Shoalhaven Heads, 140 kilometres south of Sydney. The mammals and avifauna of the Park have been examined in some detail (Robinson, 1987, NPWS, 1991). In contrast information on the Park's herpetofauna is scarce (Mills, 1988; Mitchell McCotter, 1992). The existing information concerning the fauna in the general area of Seven Mile Beach was summarised by Daly (1993); six frog and seven reptile species were recorded. One further reptile species has been reported by Whelan (1992) and another four by Ehmann (pers comm). The aim of this survey was to examine the range of herpetofauna occurring within the National Park. A list of species identified during the survey is presented. The distribution of each species is discussed in relation to the Park's major vegetation types. Their occurrence in the area surrounding the Park is also briefly noted. A list of additional species which may occur is also presented, based on study of the potential habitats available in the Park, and information on the species in the Nowra area.

STUDY AREA

The substratum within the Seven Mile Beach National Park is composed of Quaternary to Recent sands. Rock outcrops are absent. The only permanent freshwater is Coomonderry Swamp in the extreme west of the Park. This is the largest freshwater swamp in coastal NSW (Goodrick, 1970), covering an area of approximately 580 hectares. Only a portion of this extensive swamp is within the Park boundary, the remainder being under private ownership. The vegetation of the Park progresses from the ocean beach to the swamp through a series of types (modified from Mitchell McCotter, 1992):

1. the foredune colonised with spinifex (*Spinifex hirsutus*), coast wattle (*Acacia longifolia*) and the introduced pennywort (*Hydrocotyle bonariensis*).

2. dense coastal teatree (*Leptospermum laevigatum*) scrub on the second dune, with coast banksia (*Banksia integrifolia*) and a sparse ground cover dominated by lomandra (*Lomandra longifolia*).

3a. open eucalypt forest dominated by blackbutt (*Eucalyptus pilularis*) and bangalay (*Eucalyptus botryoides*), with an understorey including black she-oak (*Allocasuarina littoralis*), old man banksia (*Banksia serrata*) and coastal bearded heath (*Leucopogon parviflorus*). Dense ground cover including bracken (*Pteridium esculentum*), blady grass (*Imperata cylindrica*) and guinea flower (*Hibbertia scandens*). This type constitutes the major vegetation in the park.

3b. towards the north the blackbutt/bangalay forest overlays a littoral rainforest understorey dominated by cheesetree (*Glochidion ferdinandi*), with sweet pittosporum (*Pittosporum undulatum*), lillypilly (*Acmena smithii*), and a sparse ground cover.

4. swamp mahogany (*Eucalyptus robusta*) woodland close to the margin of Coomonderry Swamp, with swamp oak (*Casuarina glauca*), coast banksia (*Banksia integrifolia*), saw sedge (*Gahnia sieberana*) and a dense ground cover of grass and rushes.

5. paperbark (*Melaleuca ericifolia and Melaleuca linariifolia*) scrub on the margin of the swamp with a dense ground cover of rushes.

6. Coomonderry Swamp with an extensive dense reedland of tall spike rush (*Eleocharis sphacelata*), common reed (*Phragmites australis*) and cumbungi (*Typha orientalis*).

The Park and Coomonderry Swamp are isolated from large areas of native vegetation. Smaller areas occur nearby; the closest are at Gerroa/Crooked River immediately to the north (littoral rainforest and swamp mahogany woodland), Coolangatta Mountain 1.5 kilometres to the south-west (eucalypt forest and rainforest) and Moeyan Hill two kilometres to the west (eucalypt forest). The remainder of the area between the park and the escarpment ten kilometres to the west has largely been cleared for agriculture or urban development.

METHODS

The survey was conducted between 14 December 1993 and 14 June 1994; thereby including the seasons for both summer-breeding and winter-breeding species in the Nowra area. Survey methods involved direct observation by day, nocturnal observation using a 100 watt spotlight, lifting timber and rubbish, identification by diagnostic call, pit-fall trapping, and examination of road kills.

Some or all of the above methods were employed opportunistically at each of 35 sites, selected to sample all vegetation types in all areas of the park. Results of species abundance are presented in general, qualitative terms as:

1. abundant (more than forty found)
2. common (ten to forty found)
3. uncommon (three to nine found)
4. rare (one or two found)

Comments on the distribution of animals in the surrounding area were based on unpublished reports, the author's personal observations, and personal communications with other biologists and with local landholders. Records are based on the author's personal observations unless otherwise stated.

RESULTS

Nine frog species from two families have been recorded in the Park. Seventeen reptile species from seven families have been recorded in the Park. An additional five species may also occur there.

Species Recorded in the Park

FROGS
HYLIDAE

Green and golden bell frog (*Litoria aurea*)

Common in the Park at only one site, in swamp mahogany woodland grading to blackbutt/bangalay forest near the eastern edge of Coomonderry Swamp. Recorded from January to March. An additional single record in blackbutt/bangalay forest 1500 metres to the north indicated a wider distribution within the park. Recorded on the western edge of Coomonderry Swamp by

H. Ehmann in November 1993 (pers comm) and in breeding aggregations in dams in agricultural land within 800 metres of the swamp in February 1994 (pers obs), but is otherwise apparently absent from the surrounding area. The species is currently listed on the Amended Schedule 12 of the National Parks and Wildlife Act 1974 as a Threatened Species.

Green tree frog (*Litoria caerulea*)

Rare in the Park in blackbutt/bangalay forest. A single record in March. Widespread but rare in the surrounding agricultural area. Recorded at Broughton Creek (6 kilometres west) and Bolong (7 kilometres west). Generally rare in the Nowra area.

Bleating tree frog (*Litoria dentata*)

Common in the Park in blackbutt/bangalay forest. Recorded from December to June. Frequently found sheltering in artificial sites at the picnic area. Common throughout the surrounding agricultural area.

Jervis Bay tree frog (*Litoria jervisiensis*)

Common in the Park's reedland. Recorded from March to June. Common throughout Coomonderry Swamp and near dams and gutters in the surrounding agricultural area.

Peron's tree frog (*Litoria peronii*)

Uncommon in the coastal teatree scrub and common in the blackbutt/bangalay forest in the Park. Recorded from December to June. Frequently found sheltering in artificial sites at the picnic area and camping ground. Common throughout the surrounding agricultural area.

Tyler's tree frog (*Litoria tyleri*)

Rare in blackbutt/bangalay forest in the Park. A single record in May. Recorded in forest bordering agricultural land 200 metres west of the Park (Daly, pers comm).

Verreaux's tree frog (*Litoria verreauxi*)

Commonly recorded during the survey in dams in the surrounding agricultural land, the closest record within 400 metres of the Park. It has previously been recorded in the Park near the picnic area by H. Ehmann (pers comm).

MYOBATRACHIDAE

Common froglet (*Crinia signifera*)

Abundant in the Park's reedland, paperbark scrub and swamp mahogany woodland. Uncommon in the littoral rainforest in the north of the Park. Recorded from March to June. Abundant throughout the surrounding agricultural area.

Brown-striped frog (*Limnodynastes peronii*)

Abundant in the Park's reedland, paperbark scrub and swamp mahogany woodland, breeding in the swamp mahogany woodland when this was inundated following heavy rain in April. Uncommon in the blackbutt/bangalay forest. Recorded from December to June. Abundant throughout the surrounding agricultural area.

REPTILES

CHELIDAE

Eastern snake-necked turtle (*Chelodina longicollis*)

Rare in the Park's reedland. Recorded in February and June. The turtle is widespread and common in dams and ditches in the surrounding agricultural area and is probably also common in Coomonderry Swamp, albeit seldom seen.

VARANIDAE

Lace monitor (*Varanus varius*)

Rare in blackbutt/bangalay forest in the Park. A single record in December. It has not been recorded in the surrounding agricultural area or any of the nearby natural areas in recent times. The closest known population is at Bomaderry Creek Reserve (thirteen kilometres to the west).

AGAMIDAE

Jacky lizard (*Amphibolurus muricatus*)

Common in the Park in coastal teatree scrub and blackbutt/bangalay forest, rare in the foredune vegetation. Recorded from December to May. Reported from Beach Road (500 metres west of the Park) (Virtue, pers comm), otherwise apparently absent from the surrounding area. The closest known population is at Bomaderry Creek Reserve.

SCINCIDAE

She-oak skink (*Cyclodomorphous casuarinae*)

Rare in the Park in dense grass in the swamp mahogany woodland bordering the swamp. A single record in April. The species has been recorded at Gerroa (Whelan, 1992).

Eastern water skink (*Eulamprus quoyii*)

Abundant in the Park in the paperbark scrub and swamp mahogany woodland bordering the swamp. Common to uncommon in the blackbutt/bangalay forest, littoral rainforest and coastal teatree scrub. Recorded from December to April. Widespread and common near water in the surrounding agricultural area.

Barred-sided skink (*Eulamprus tenuis*)

Not recorded during the survey. The preferred habitat of this arboreal species is rainforest and eucalypt forest (Swan, 1990) and it has previously been recorded in these vegetation types at the Park's picnic area (Ehmann, pers comm).

Grass skink (*Lampropholis delicata*)

This was the commonest reptile species encountered in the Park. Recorded from December to June. Abundant throughout the coastal teatree scrub, blackbutt/bangalay forest, littoral rainforest and swamp mahogany woodland, particularly near tracks, clearings, and edges, where sunlight reaches the ground. Common to rare on the foredune. Abundant throughout the area surrounding the Park.

Garden skink (*Lampropholis guechinoti*)

Abundant on the foredune. Uncommon in the coastal teatree scrub and blackbutt/bangalay forest. Recorded from February to June. No information on occurrence in the surrounding area.

Three-toed skink (*Saiphos equalis*)

Rare in blackbutt/bangalay forest. A single animal was found in sandy humus beneath rubbish in April. Not previously recorded in the Nowra area. The closest known population is at Jamberoo (20 kilometres north) (Swan, 1990).

Weasel skink (*Saproscincus mustelinus*)

Not recorded during the survey. This species has previously been found in the Park by H. Ehmann (pers comm) on the eastern edge of Coomonderry Swamp.

Common bluetongue (*Tiliqua scincoides*)

Uncommon in blackbutt/bangalay forest in the Park. Recorded from January to February. Common throughout the surrounding area; records from Broughton Creek, Shoalhaven Heads

village (immediately south of the park) (Whiteoak, pers comm), Coolangatta Mountain (Bishop, pers comm), Moeyan Hill (Grant, pers comm) and Gerroa (Whelan, 1992).

BOIDAE

Diamond python (*Morelia spilota spilota*)

Uncommon in the Park in the blackbutt/bangalay forest. Recorded in February. Previously recorded in the coastal teatree scrub (Saals, pers comm) and the littoral rainforest (Reid, pers comm). The species was a frequent road kill victim, constituting three of the five road killed snakes found in the Park during the survey. One specimen is lodged in the Australian Museum (R143569). Records from Gerroa (Whelan, 1992), Coolangatta Mountain (Bishop, pers comm) and Moeyan Hill (Christian and Grant, pers comm).

ELAPIDAE

Small-eyed snake (*Cryptophis nigrescens*)

Not recorded during the survey. The habitat of this species includes rainforest and eucalypt forest (Swan, 1990) and it has previously been recorded in these vegetation types in the Park by H. Ehmann (pers comm). The species has also been recorded on the western edge of Coomonderry Swamp (Ehmann, pers comm).

Black-bellied swamp snake (*Hemiaspis signata*)

Rare in the Park in blackbutt/bangalay forest. The single specimen (a road kill) was found in February and is lodged in the Australian Museum (R143568). No records from the surrounding area; the closest record is Culburra (10 kilometres south) (Daly, pers comm). An isolated population may be common around Coomonderry Swamp.

Eastern tiger snake (*Notechis scutatus*)

Rare in blackbutt/bangalay forest in the Park. A single record in April. Previously recorded in the swamp mahogany woodland (Reid, pers comm). Common in the surrounding area; reports from Shoalhaven Heads village (Whiteoak, pers comm), Beach Road (Virtue, pers comm), Coolangatta Mountain (Bishop, pers comm) and Moeyan Hill (Grant, pers comm).

Red-bellied black snake (*Pseudechis porphyriacus*)

Uncommon in the Park in littoral rainforest and blackbutt/bangalay forest. This was the commonest snake seen during the survey, recorded from December to March. Common throughout the surrounding area.

HYDROPHIIDAE

Yellow-bellied seasnake (*Pelamis platurus*)

A single near-dead animal was found beached on the eastern boundary of the Park in August 1994. The specimen is lodged in the Australian Museum.

Additional species which may occur in the Park

REPTILES

PYGOPODIDAE

Common scaly-foot (*Pygopus lepidopodus*)

The habitat of this species includes open forest, woodland and coastal dunes (Ehmann, 1992). The species is rare in the Nowra area but may occur in these vegetation types in the Park. The closest record is Jervis Bay (25 kilometres south) (Daly, 1994).

AGAMIDAE

Eastern water dragon (*Physignathus lesueurii*)

Recorded near the southern end of the Park along drains adjoining Coomonderry Swamp (Daly, pers comm), in moist gullies at Moeyan Hill (Grant, pers comm) and along Blue Angle Creek near the northern end of the Park (Ehmann, pers comm). The species may occur in the Park along the margin of Coomonderry Swamp.

ELAPIDAE

Death adder (*Acanthophis antarcticus*)

The habitat of this species includes dry sclerophyll forest and woodland (Swan, 1990). It is rare in the Nowra area but may occur in these vegetation types in the Park. The closest record is Jervis Bay (Daly, 1994).

Golden-crowned snake (*Cacophis squamulosus*)

The habitat of this species includes rainforest and moist areas in sclerophyll forest (Swan, 1990). It has been recorded at Crooked River within 100 metres of the Park by H. Ehmann (pers comm).

Eastern brown snake (*Pseudonaja textilis*)

Recorded at Moeyan Hill (Christian and Grant, pers comm) and Beach Road (Virtue, pers comm). Open eucalypt forest provides suitable habitat (Swan, 1990) and it is probable that the species occurs in this vegetation type in the Park. There is one uncertain record for the Park (Cotterill, pers comm).

DISCUSSION

It is interesting to compare the diversity of herpetofauna recorded during this survey to that found at other sites in the Nowra area. Fourteen frog and fifteen reptile species have been recorded in the Jervis Bay National Park (30 kilometres south) (Daly, 1994), which has a terrestrial area of approximately 5470 hectares. Ten frog and eighteen reptile species have been recorded in the Bomaderry Creek Reserve (Daly and Murphy, 1994), which has an area of approximately 230 hectares. Both sites have a greater range of habitats than Seven Mile Beach National Park, with creeks and rock outcrops being of particular value. A greater range of species can therefore be expected. Conversely, Seven Mile Beach National Park contains species, such as the three-toed skink and black-bellied swamp snake, which have not been recorded to date at either of the other two sites.

The Park's size (one of the state's smallest), together with its narrow shape and a busy road along its long boundary, presents a danger for mobile reptile species such as the snakes and the lace monitor, which may suffer road kill death rates greater than their population size can sustain. Observations also indicated that a great part of the Park's frog populations cross the road to Coomonderry Swamp to breed. If warm wet nights during the summer breeding season coincided with public holidays adult frogs could be killed in numbers greater than some species could sustain. Ehmann (pers comm) counted 210 road killed frogs in a distance of 300 metres along this road in 35 minutes on one night in early summer 1992.

The introduced mosquito fish (*Gambusia affinis*) was noted to be abundant in Coomonderry Swamp. The introduced goldfish (*Carassius auratus*) was noted to be common in drains adjoining the swamp and is probably common in the swamp itself. Both species eat tadpoles and their presence there decreases its value as frog habitat. It is probably impossible to eradicate these fish from the swamp. A more realistic strategy to assist frogs to breed in the area may be to encourage local landholders to eradicate the fish from their stock dams.

The isolation of Seven Mile Beach National Park from other areas of natural vegetation presents problems for the management of the Park's fauna in general, local extinctions being a real possibility. The observations documented above concerning the herpetofauna in the area surrounding the Park are largely anecdotal, but suggest that many species are not isolated in the Park, but occur widely in the surrounding agricultural area. The security of six species however, (the green and golden bell frog, green tree frog, lace monitor, jacky lizard, three-toed skink and black-bellied swamp snake) is of concern. Available information suggests that all are rare or absent in the area surrounding the Park. All except the jacky lizard were recorded as rare or uncommon in the Park during the survey. Further investigation of their status and security in the Park is recommended.

Seven Mile Beach National Park supports a surprising array of reptiles and amphibians considering its size, isolation, latitude and lack of rock outcrops and creeks. Further study may reveal additional species. The herpetofauna constitutes an interesting and valuable component of the Park's vertebrate fauna. It is hoped that the information gained from this survey will assist in the management of the Park.

ACKNOWLEDGEMENTS

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REPRODUCTION NOTES AND THE FIRST RECORD OF ALBINISM IN THE WHITE CROWNED SNAKE *CACOPHIS HARRIETTAE* (SERPENTES: ELAPIDAE)

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Albinism has been recorded in a number of Australian snake genera including *Notechis* (Mirtchin and Davis, 1987), *Pseudechis* (Sambono, pers. comm.), *Pseudonaja* (Covacevich, pers. comm.), *Demansia* (Covacevich, pers. comm.), *Hoplocephalus* (Gow, 1989), *Hemiaspis* (Shine, 1991), *Cacophis* (Shea and Kent, 1988). The authors present the first recorded example of albinism in the *Cacophis harriettae.*

C.harriettae is commonly found in the Brisbane area (Covacevich, 1970). It is secretive, nocturnal and spends most of its time resting under leaf litter, fallen timber and rock (pers. obs.). Skinks comprise the bulk of its diet (Shine, 1980). Although venomous it is not considered dangerous and rarely bites (Ehmann, 1992).

C.harriettae bears between 2 to 10 soft shelled eggs (Shine, 1980). The dorsal coloration is usually dark brown to steely gray with a white stripe around the side of the head, enclosing the snout, becoming more prominent at the base of the head giving a distinct crowned appearance. The ventral surface is usually lead gray in colour (Shine, 1980).

On the 2nd December 1993 the authors found a gravid albino specimen of *C.harriettae* . The specimen was found at 11.30pm on a warm and overcast night on Crowson Lane, Park Ridge, south-east Queensland. The road is bordered by dry sclerophyll woodland. Our identification was confirmed at the Queensland Museum by Jeanette Covacevich and Patrick Couper. The snake measured 490mm snout-vent length and weighed 59g. The snake was completely white apart from the crown which was a light rust colour. The eyes displayed the usual red albino colour.

On the 12th December the snake deposited 7 eggs in a container of moist vermiculite. Following egg deposition, the female weighed 39.1g. Egg measurements and weights are given in Table 1. The eggs were maintained at room temperature with a 24 hour fluctuation of 20°C to 30°C.

Table 1. Dimensions and weight of *C.harriettae* eggs.

	Length (mm)	Width (mm)	Weight (mm)
1	25.16	14.15	3.2
2	27.58	14.30	3.5
3	27.37	14.04	3.1
4	23.29	14.37	2.7
5	21.78	14.61	2.0
6	23.16	14.46	2.8
7	24.09	14.31	2.1
Mean	24.63	14.32	2.86
S.d.	2.19	20	48
Range	21.78-27.58	14.01-14.61	2.0-3.5

After 72 days of incubation the neonates began to emerge on the 12/2/94. By the 14/2/94 all 7 neonates had emerged out of the eggs, and were measured and weighed (Table 2).

Table 2. Body lengths and weights of the neonate *C.harriettae*

	SVL (mm)	TL (mm)	Weight (g)
1	75	5	1.25
2	86	4	1.26
3	75	5	1.25
4	65	5	1.24
5	55	5	1.20
6	75	5	1.25
7	75	5	1.25
Mean	72.3	4.8	1.24
S.d.	9	.37	.02
Range	55-86	4-5	1.2-1.26

None of the neonates exhibited albinism as displayed by the female, being all of normal coloration for the species. The adult female *C.harriettae* and the neonates were released at the female's site of capture.

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REDISCOVERY AND TAXONOMIC REVIEW OF *VARANUS INDICUS SPINULOSUS* MERTENS, 1941

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ABSTRACT

Varanus indicus spinulosus Mertens was described from a single male specimen in 1941, and had not been collected again until 1989. Five new specimens, all female, two preserved and three alive, are described and compared with *Varanus indicus*. Based on distinctive morphology, this taxon is elevated to specific status as *Varanus spinulosus* comb. nov.

Key words: *Varanus spinulosus*; *Varanus indicus*; monitor lizards; taxonomy; rediscovery; Solomon Islands.

INTRODUCTION

Most varanid lizards are large, conspicuous carnivores, making them important elements in terrestrial vertebrate faunas. Nevertheless, some of the largest species have been unknown to science until rather recently. Examples of such taxa include Gray's monitor, *V.olivaceus*, described in 1856, but virtually unknown until the 1970s (Auffenberg, 1976, 1988), *V.teriae* (Sprackland, 1991), and *V.yemenensis* (Böhme *et al*, 1989). A partial explanation for the hiatus between discovery and study must include the remote localities inhabited by the lizards.

Such is probably the case for *Varanus indicus spinulosus* Mertens, 1941, described from a single male specimen from Georgs (= San Jorge) Island, Solomons. Though he clearly felt it was closely allied to *Varanus i.indicus*, Mertens distinguished the new taxon by three morphological traits: (1) a shorter, broader, higher snout; (2) melanism; and (3) distinct, spike-like nuchal and dorsal scales. Unfortunately, the holotype (NMW 23387) remained unique until 1989.

In 1989 I began a phylogenetic review of the Varanidae by studying the morphology of lizards assigned to the *V.indicus* group, i.e. *Varanus indicus*, its alleged subspecies, and *V.karlschmidti*. Five new individuals of *V.i.spinulosus* were discovered, including two preserved animals in private hands, and three live adult females at the Baltimore Zoo. This report provides information on *V.i.spinulosus* additional to the description of the holotype, and includes brief notes on the first known captive specimens.

The status of *Varanus indicus* is uncertain. In his original description, Daudin (1802) provided scant data and a poor illustration of *Tupinambis indicus*, and no type specimen was designated. Several specimens of "*indicus*" were later described under new names, including several subspecies, so that twelve synonyms are associated with mangrove monitors (i.e. *indicus* Daudin, 1802; *guttatus* Merrem, 1820 [*nomen nudum*]; *douarrha* Lesson, 1830; *kalabeck* Lesson, 1830; *chlorostigma* Gray, 1831; *doreanus* Meyer, 1874 [*nomen nudem*]; *rouxi* Mertens, 1926; *tsukamotoi* Kishida, 1929 [*nomen nudem*]; *jobiensis* Ahl, 1932; *leucostigma* Hediger, 1934 [lapsus]; *spinulosus* Mertens, 1941; and *karlschmidti* Mertens, 1950). A major goal of this study, to find the "lost" types for the first six of these taxa, and designate neotypes or lectotypes where necessary, is being presented separately. However, the only taxon from the Solomon Islands designated a holotype is *V.i.spinulosus*. It is distinct enough in morphology not to be confused with either specimens or descriptions of other mangrove monitors.

MATERIALS AND METHODS

I examined 236 preserved specimens of mangrove monitors, representing the complete holdings for the BMNH, CAS, MCSNG, MHNP, NMW, RMNH, SMF, ZMB and ZSM. Also

examined were numerous live specimens and skulls in both private and public collections; sources of specimens are listed under acknowledgements. Lizards were examined for colouration, pattern, scalation, tongue colour, nostril position, and snout shape. Representatives of all patterns were photographed, and many were drawn by hand. Because types for several named taxa were unavailable, comparative materials were based on topotypes, which were available for all names. Institutional abbreviations follow Leviton *et al.* (1985).

Original descriptions were compared with type material (where available) or with specimens from type localities. Notes on live specimens and photographs of *Varanus spinulosus* were obtained through Andrew Wisnieski (Baltimore Zoo) and Howard Delisle.

RESULTS

The absence of types made ascertaining available names difficult, especially in relation to members of the distinct *V.indicus* species group. In fact, the composition of "*Varanus indicus*" is uncertain, composed of at least three valid, named taxa (*indicus, jobiensis*, and a cryptic form currently being described [Böhme and Horn, pers. comm.]). By using topotype specimens and original descriptions, it was possible to determine that no description was based on specimens from the Solomon Islands chain, nor was any description applicable to *V.i.spinulosus* except that by Mertens himself (1941). Lesson's (1830) description of *Varanus douarrha* is based on a single specimen from New Ireland, the closest locality for any type in the complex relative to *spinulosus*. The specimen is presumed lost, and though incomplete in many details, the description of colouration does not match the pattern found in the Solomon Islands lizards. Monitors from St George and Ysabel Islands are morphologically distinct, both from other Solomon Islands varanids, and from any other population of mangrove monitors available for study. For this reason, it is appropriate to elevate the taxon *spinulosus* to specific rank:

Varanus spinulosus Mertens, 1941 Comb. Nov. Figs 1-6

Varanus indicus spinulosus Mertens, 1941. NMW 3709 (old number), adult male. "Albatross" - Reise 1897, Terra typica: Georgs Insel, Solomonen.

SPECIMENS EXAMINED: NMW 23387 (=NMW 3709), Holotype; RGS 215, preserved adult female; CAS 180743, adult; and three living specimens, all females (Wisnieski, pers. comm.), at Baltimore Zoo; all collected by Levi Tabo, Ysabel Island, Solomon Islands, 1989.

DIAGNOSIS: A medium sized varanid distinguished from *V.i.indicus* by (1) spiked, hull-shaped nuchal and dorsal scales that are widely separated from each other; (2) a dark brown to black dorsum with distinct bands of very large, solid, round light spots, each spot of more than 6 scales, (3) a pink tongue, (4) a round nostril positioned closer to the snout tip than to the orbit, (5) distinct, light caudal bands that are 1-2 scales in width, (6) an unspotted head, (7) a sharply pointed snout tip that is barely compressed anterior to the nostril, (8) subequal scales of the forearm, and (9) a uniform dark venter, about the same colour as the dorsum.

Characters 1, 2, 5, 7, 8 and 9 separate *Varanus spinulosus* from *V.jobiensis*. It is also distinguished from *V.jobiensis* in having a dark (vs light) face, and in lacking a temporal streak (*V.jobiensis* has a single, black streak).

DESCRIPTION: Snout acute, coming to a distinct point when viewed from lateral or dorsal perspectives; nostril small, round, and closer to tip of snout than to orbit; snout depressed at tip, anterior to nostrils, but not so conspicuously as the step-like morphology seen in *Varanus indicus* or *V.prasinus*. Four scale rows beneath nostril; enlarged supraoculars number 7-8; upper head scales individually smooth, slightly convex, giving region an overall rugose texture. Tongue pink for its entire length. Chin with indistinct whitish markings along lower border of dentaries, otherwise unmarked; gular scales flat, smooth, or with very feeble keel. Anterior nuchal scales smaller than posterior occipitals; nuchals shaped like the hull of a boat, and acute,

not as sharply keeled or as large as in *Varanus beccarii*; dorsal scales, especially vertebrals, somewhat larger than nuchals; ventrals rectangular, distinctly keeled; preanal pores absent.

Scales around forelimb subequal. Palmar surface with round, light, keeled scales.

Tail compressed dorsally along distal two-thirds its length, approximately as broad as high for distal half its length; double dorsal row of keeled scales distinct.

COLOUR: In life, the dorsal colouring is deep chocolate brown, becoming more of a tan below. Dorsum with large, solid spots of lime green or yellowish, these forming four distinct transverse bands, of four spots each, from shoulders to hips. The anteriormost pair of vertebral spots touch mid-dorsally. Head and forelimbs lack light markings; no post temporal stripe. Extreme tip of snout white or cream. Lining of mouth and tongue light pink. Ventrally faintly mottled with charcoal and light spots. Upper surface of tail with distinct, light, thin bands, those on the distal two-thirds of tail only two scales wide. Between these bands are a few small, light spots, each one to two scales in size.

DISTRIBUTION: San Jorge (= San Georgs, St George) Island, the type locality, is a tiny accessory to Ysabel (= Isabel) Island, Solomon Islands. The specimens collected in 1989 were taken on the much larger Ysabel Island.

BEHAVIOUR: We have little information on behaviour. Male *V."indicus"* introduced to the female *V.spinulosus* at Baltimore Zoo were not inclined to attempt mating. The same males, introduced to female *V."indicus"*, quickly initiated successful mating behaviour. This may suggest that reproductive reciprocity is rare or nonexistent, but may also relate to seasonal or behavioural distinctions in closely related lizards from different populations.

Delisle (pers. comm.) relates that his specimen would accept only fish, refusing insects and rodents; the Baltimore Zoo specimens are taking rodents without problem.

DISCUSSION

Following Wiley's (1981) suggestions, I designate a species as such if it has (1) a distinct phenotype that is (2) not dependent upon geographical data. Both criteria apply to *V.spinulosus.* In addition, *V.spinulosus* is sympatric with *V."indicus"* on Ysabel Island (Lemke, pers. comm.; Philippen, pers. comm.), but both taxa are quite distinct phenotypically. Live specimens of *V."indicus"* from Ysabel are frequently imported into the U.S. animal market, yet show no distinct similarities to *V.spinulosus*. For these reasons, *Varanus spinulosus* should be considered a distinct species from *V."indicus"*.

The systematic position of *V.spinulosus* is presently unclear, for it shows a curious combination of characters seen in related varanids. *V.spinulosus* shares several characters with the *V.prasinus - V.indicus* group (Böhme, 1988; King *et al*, 1991; Sprackland, 1991) including the synapomorphies 1) lack of preanal pores, 2) predominantly dark/unicolour dorsum, and 3) presence of green or turquoise colouring. The autapomorphies for *V.spinulosus* are the subequal forearm scales and the distinct dorsal and ventral colouration. The anterior nostril position is interpreted as plesiomorphous (Böhme, 1988; Sprackland, 1991). The enlarged supraocular scales, keeled dorsals and ventrals, and 22-23 supralabials are seen as symplesiomorphies that are shared with *Varanus salvator, V.prasinus,* and *V.indicus.*

The status of *Varanus jobiensis* Ahl, 1932 has been clarified by Böhme (1991). He reexamined the holotype in Berlin and compared it with recently collected specimens of *V.karlschmidti* Mertens, 1950, and found them to be the same taxon. Consequently, *V.karlschmidti* is a junior synonym of *V.jobiensis.* The remaining ten available names for members of the *V."indicus"* assemblage were given to taxa from the Moluccas and New Guinea, none being applicable to *V.spinulosus* except *spinulosus.*

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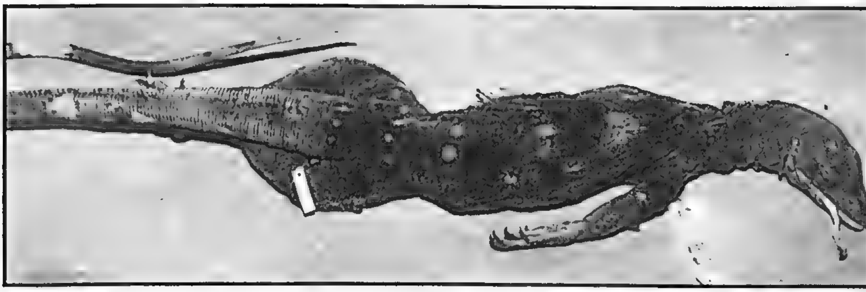

Fig. 1. Holotype of *Varanus spinulosus* (NMW 3709), adult male, entire animal.

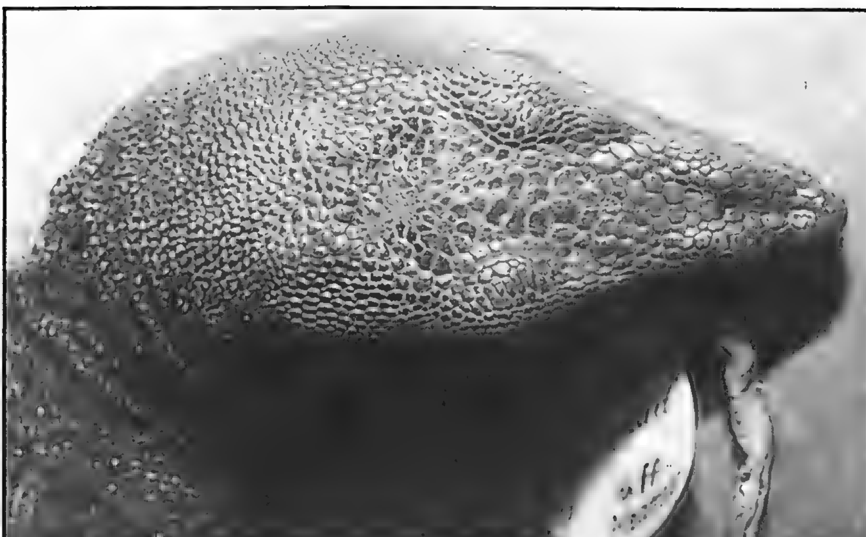

Fig. 2. Holotype of *Varanus spinulosus*, dorsal view of head.

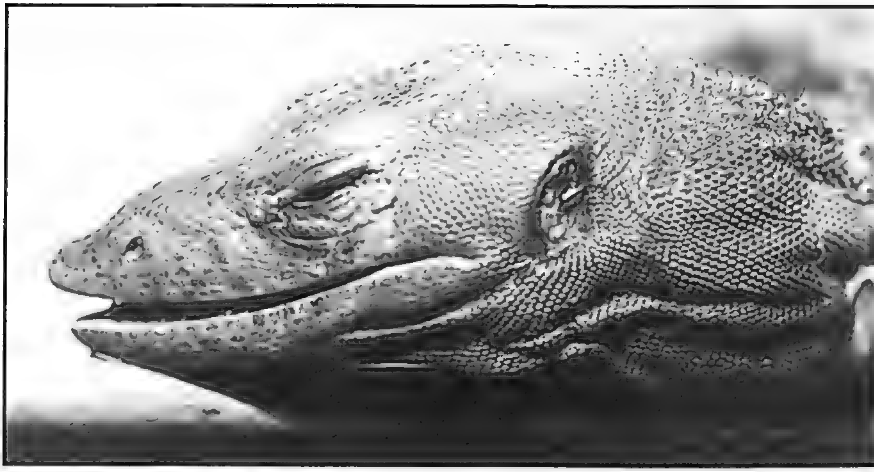

Fig. 3. Holotype of *Varanus spinulosus*, lateral view of head.

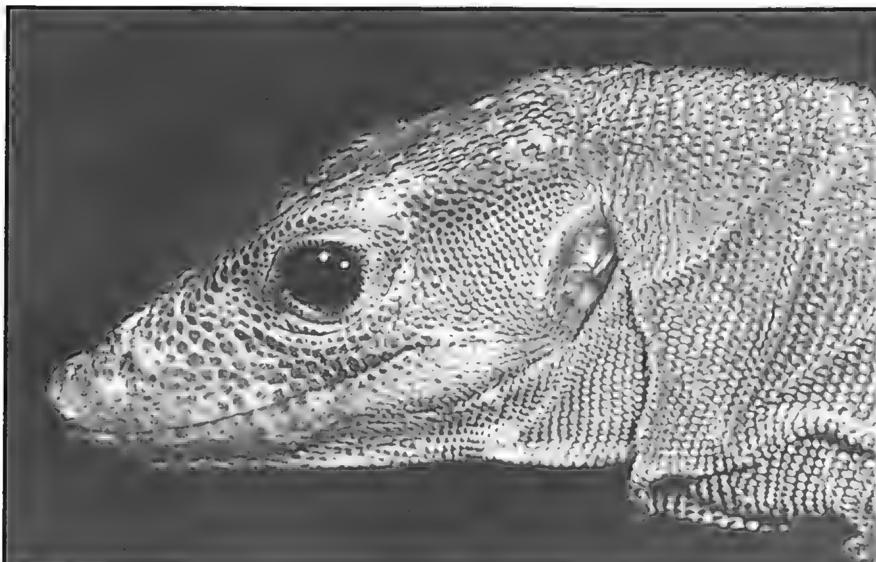

Fig. 4. Live adult female of *Varanus spinulosus* at Baltimore Zoo.

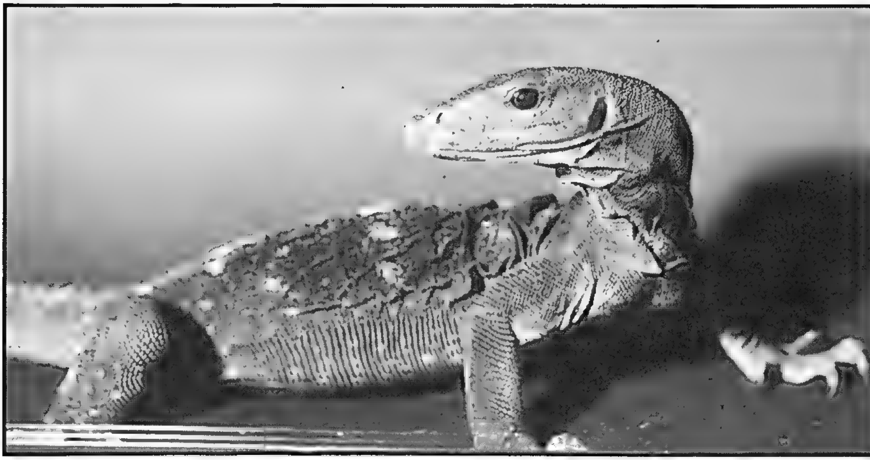

Fig. 5. Same animal as seen in Fig. 4, close-up of head.

Fig. 6. Map of the Solomon Islands (from McCoy, 1980).

(Figs 4 and 5 by Andrew Wisnieski; all others by R.G. Sprackland).

HERPETOLOGICAL NOTES

COMBAT BEHAVIOUR IN THE RAINFOREST SKINK *CARLIA RUBRIGULARIS*

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On the 30th May 1993, I observed two aggressive interactions between adult *Carlia rubrigularis* at Mossman Gorge (16°29'S, 145°20'E). Both combat bouts occurred in sunny patches in rainforest.

The first involved two large lizards, one with a tail, one without. They laterally oriented, flattened their bodies dorso-ventrally and also tilted towards each other such that the dorsal surface was almost vertical. During the course of the combat the lizards bit each other several times, body rolling when they had a firm grip. The tailed individual eventually chased the tailless one away. It also then chased away a juvenile lizard. The whole bout lasted less than five minutes.

The second combat was much the same. On this occasion, following combat, the victor investigated another adult lizard, tongue-flicking its cloacal region before rapidly moving away. In neither case were the sexes of the lizards determined.

These observations are interesting in that the combatants did not exhibit the typical "neck-arching" behaviour that is the most commonly used assertion display in skinks (Carpenter and Ferguson, 1977; Done and Heatwole, 1977; Torr, 1990). Instead, they flattened themselves considerably and oriented their dorsal surfaces towards each other. Similar behaviour has been observed in *C.rostralis*, another rainforest skink of a similar size to *C.rubrigularis* (Whittier and Martin, 1992). *C.rubrigularis* also displays considerable dorso-ventral flattening when basking (pers. obs.). In the context of combat, the tilting and flattening of the lizards' bodies clearly represents an attempt to increase their apparent body size and profile and may also serve to make it more difficult for an opponent to bite the tilting lizard in the trunk region.

These observations represent further evidence for the high behavioural diversity within the Scincidae (Torr and Shine, 1994). The possible presence of a consistent and unique aggressive display within the genus *Carlia* merits further investigation. It suggests that this genus would make an excellent subject for research into the evolution of lizard social behaviour.

ACKNOWLEDGEMENTS

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OBSERVATIONS OF COMMUNAL HIBERNATION IN THE EASTERN SNAKE-NECKED TURTLE (*CHELODINA LONGICOLLIS*)

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This is an account of two hibernation sites of the Eastern Snake-Necked Turtle, *Chelodina longicollis*, which I have observed since May 1991. The process of finding the turtles involves feeling around in the mud at the bottom of waterways with the hands and feet, sometimes termed "muddling". Once a turtle has been located it is inspected, marked and details recorded before its release at the point of capture.

The first site is a shallow lagoon located on Gunbower Island, north of Cohuna, Vic.

Although a number of logs (N12) appeared suitable as sites only one semi-hollow log was actually used as a hibernation site over the three year period. The number of *C.longicollis* using this site were; 1991 - 10, 1992 - 8 and 1993 - 2, no other species were present.

All the *C.longicollis* found during 1991 and 1992 were marked with a series of notches on the marginal scutes of the carapace. This method was used to determine if individuals use the same hibernation site from year to year. Since being marked in 1991, no individuals have returned to this site.

The second site is a small outlet channel off Lake Boort, Victoria. Due to the size of this lake only an area of water 60m x 30m, plus 2 dams and a channel leading from the lake, were surveyed. The channel was approx. 1.2m deep, with another 0.5m of black mud, in the deepest part to 0.5m deep (plus 0.5m mud) in the shallows. The site where the tortoises were found was 10m x 3m with a mat of "grass". The *C.longicollis* were buried in the mud below. The number caught over the three year period were; 1991 - 10 (plus 1 dead), 1992 not recorded, 1993 - 32 (plus 3 dead), no other species were present. Turtles were not marked at this site. Evidence at this site suggests a species of water rat is feeding on the hibernating turtles (Green, in prep).

Communal hibernation is a relatively common event in reptiles. But in the case of aquatic turtles there is little information available on such communal habits. At Gunbower Island and Lake Boort, *C.longicollis* had a choice of many logs, aquatic plants and water bodies in which to hibernate, but showed a preference for particular sites. Possible explanations may include security in numbers or a greater chance to breed in the spring emergence.

A NOTE REGARDING COLOUR CHANGE IN *DEMANSIA PSAMMOPHIS PSAMMOPHIS* (SERPENTES: ELAPIDAE)

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On 15 January, 1992 I was attempting to photograph a specimen of *Demansia p. psammophis* that had been collected the previous day. At the time of capture, it had appeared a 'typical' Kambalda specimen - dark olive green dorsally with a pale brown head and tail. Now it appeared to be bluish-green dorsally. Efforts to photograph it were proving futile, its constant activity being aided by the warmth of the day. After five minutes or so I noticed its colour had definitely changed to blue dorsally and the head and tail pale orange.

I had previously seen the occasional *D.p.psammophis* exhibit this colouration in Kambalda, (31°12'S, 121°40'E), but thought it to be variation within the subspecies. Certainly I was unaware that individuals were capable of such a rapid and marked colour shift. In view of the circumstances it appears the change was a result of temperature/activity.

BEHAVIOURAL NOTE ON THE THORNY DEVIL (*MOLOCH HORRIDUS* GRAY, 1841)

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The thorny devil (*Moloch horridus*) is probably one of the most bizarre of the Australian reptiles. Even so, the natural history of this species is still poorly understood (Greer, 1989).

While on a field trip to the Middleback Ranges (33°10'S, 137°08'E), near Whyalla, we were fortunate enough to encounter three *Moloch horridus* specimens. We collected each of them, with the intention of taking photographs. On the 8th October 1992, we released the animals in the centre of a sandy track. Shortly after release the smallest of the three began to move about with its tail erect, demonstrating a series of head bobbing movements similar to that described by Sporn (1965) and Johnston (1981). After repeating this behaviour for approximately 5 minutes, this individual moved across to one of the other animals that had been released. The second animal immediately adopted a posture with the ventral surface, head and tail lying flat on the sand. The smaller individual then attempted to climb onto the dorsal surface of the second. Part way through the mounting attempt the two individuals suddenly flipped onto their backs. This action was extremely rapid and it was difficult to determine which individual instigated the behaviour. This was repeated three or four times with the smaller individual head bobbing between each attempt. Eventually the smaller individual lost interest and moved away. The sex of the animals involved was not determined; however, males are generally much smaller than females (Pianka and Pianka, 1970), suggesting that the individual making the advances was a male.

Flipping (as described above), head bobbing and alteration in orientation of the body are the only social interactions that have been recorded for this species (Houston, 1978, Johnston, 1981, and Greer, 1989).

Greer (1989) interpreted observations in *Moloch*, similar to those we have described, as an aggressive behaviour adopted by a female rejecting the advances of an amorous male. A similar observation was described by Montanucci and O'Brien (1991) in a North American Iguanid. In this case it was clearly shown that the male coast horned lizard (*Phrynosoma coronatum*) flips the female onto her back and they mate in a ventral surface to ventral surface position. Considering the gross similarities in morphology between these two species it would not be unreasonable to suggest that convergence may also have resulted in a similar mating behaviour being adopted by the two species.

ACKNOWLEDGEMENTS

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PREDATION ON LIZARDS BY *CARLIA LONGIPES*

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The scincid genus *Carlia* is represented in Australia by some twenty-one species (Cogger, 1992). They are relatively small (up to 7.0 cm SVL) and are mainly terrestrial and diurnal by habit.

Members of the genus feed primarily on arthropods (Wilson & Knowles, 1988) however two species are known to prey upon vertebrates, *C.rubrigularis* on its own young (Ehmann, 1992) and *C.rhomboidalis* on its own species as well as other small skink species (Wilson & Knowles, 1988). No references were found indicating that any other members of the genus had been recorded feeding on vertebrates; however on three separate occasions *C.longipes* in an area immediately north of Cairns, Qld, have been observed doing so. Two species of skinks, a juvenile *C.longipes* (Tim Hawkes, pers. comm.) and an adult *Cryptoblepharus virgatus* as well as one species of gecko, *Lepidodactylus lugubris* have been seen to be consumed by adult *C.longipes.*

Many skinks, being opportunistic in their feeding behaviours, could be expected to feed upon smaller lizards, and saurophagy is probably a more common occurrence than is indicated by the literature. Despite the fact that the above observations involve two arboreal species (i.e. *C.virgatus & L.lugubris*) all predations were seen to occur on the ground. However, the tendency of *C.longipes* to forage off the ground in low shrubs and trees at times (Cogger, 1992; Wilson & Knowles, 1988) makes it likely that arboreal vertebrates constitute a portion of this species' diet.

ACKNOWLEDGEMENTS

Thanks to Tim Hawkes for contributing his observations for this note.

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AN ADDITION TO THE REPTILE FAUNA OF THE MOSSMAN GORGE SECTION OF DAINTREE NATIONAL PARK, NORTH QUEENSLAND

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A recent survey by Torr (1993) of the Mossman Gorge section of Daintree National Park in far north Queensland recorded a total of 15 species of reptiles and 9 species of frogs.

We briefly describe our observations of an additional species of reptile from the area - the Saw-Shelled Turtle (*Elseya latisternum*). The observations were made on a brief visit to the area during the afternoons of the 8-9th March 1994. Weather conditions were slightly overcast with intermittent sunshine and (air) temperature in the low 30's (°C).

The Mossman River cuts a course through relatively undisturbed lowland tropical rainforest. The section examined comprised a series of shallow rapids with a stony, gravel substrate and numerous large protruding granite boulders with forest extending to the water's edge, partly submerged logs and other debris from overhanging vegetation had accumulated along the margins of the river. At the time of our visit the river had a maximum depth of about 3m and was some 20m wide. The current was particularly strong in the middle of the river where water flowed unimpeded; by contrast the partly submerged boulders nearer the rivers edge tended to ameliorate the strong currents, creating pockets of relatively still water. Turbidity was low making conditions suitable for snorkling (visibility was 10m). Water temperature was in the low 20's (°C).

The first *Elseya latisternum* was sighted basking on a granite boulder protruding slightly above the water several meters from the bank of the river and a short distance from a site frequented by visitors to the gorge. Although the specimen retreated into the water on our approach, its distinctive long tail indicated clearly that it was a male. It had a carapace length of approximately 15cm which might be described as 'sub-adult' size.

Approximately two hours were spent snorkling this 100m section of the river in search of other specimens. There were many underwater rock crevices of various shapes and sizes which were occasionally occupied by fish. Most of the time was spent searching these crevices.

A further two *Elseya latisternum* were found. One specimen was found down a crevice formed by a boulder and the substrate in 3m of water and some 4m from the bank. It was a small female with a carapace length of 12.5cm. A second specimen was located swimming in open water some 2m from the opposite bank and attempted to seek refuge in a rock crevice when first noticed. It was a slightly smaller female with a carapace length of 9.8cm. Both were found in relatively calm water.

On returning to the area the next day, a sub-adult *Elseya latisternum* was again sighted basking on a boulder only meters from where a specimen was seen the previous day. On this occasion it was captured and found to be a male with a carapace length of 14.0cm. We suspect it was the same specimen.

All three specimens had a uniform tan-brown carapace with some indents along the marginals. The nuchal scute was absent. The plastron and underside of the marginals were pale yellow in colour with grey sutures. Eye colour was olive with a dark horizontal bar.

Given the small amount of time spent searching (total of 3 hours), and the presence of apparently suitable habitat both up and downstream of the section examined, our observations would seem to indicate that *Elseya latisternum* is relatively common in the river. Despite this they were not observed by Torr (1993) nor mentioned in a brief account of the rivers aquatic life by Breeden and Cooper (1992).

The survey methods as described in the report by Torr (1993), focused primarily on the search for *terrestrial* reptiles and frogs so it is perhaps not surprising that no chelids were recorded. In addition the bulk of the survey period (almost three-quarters of the total daytime hours spent searching) was conducted in the middle of the wet season (January) when presumably the river was at its peak making the task of locating or observing turtles much more difficult.

ACKNOWLEDGEMENT

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A RECORD OF SUCCESSFUL INCUBATION OF BANDY BANDY *(VERMICELLA ANNULATA)* EGGS

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A gravid female Bandy Bandy *(Vermicella annulata)* was captured at Baradine, NSW in mid January. It laid 5 eggs on the 20th January, 1994. The eggs had an average weight of 4 grams and varied in dimension from 35mm x 14mm to 37mm x 14mm.

I was asked to incubate the eggs and did so by placing them in a 1 litre plastic container half filled with vermiculite and water (60:40 w/w). The container was sealed with glad wrap and a few small holes poked into the wrap. They were incubated at a constant temperature of 29°C.

Four eggs hatched between the 23rd and 25th March 1994 (62 to 64 days). The hatchlings sat with their snouts protruding from the egg for approximately 1 day before fully emerging from the egg. They would pull back into the egg if disturbed. They were observed to adopt the looping defensive stance from birth. The fifth egg was infertile. The dimensions of the hatchlings were as follows:

	TOTAL LENGTH (mm)	MASS (gm)
1	185	3.5
2	190	3.2
3	195	3.5
4	200	3.6

A RANGE EXTENSION AND ATYPICAL HABITAT FOR THE MAINLAND POPULATION OF THE PYGMY COPPERHEAD *AUSTRELAPS LABIALIS*

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The pygmy copperhead, *Austrelaps labialis*, is endemic to the Mt Lofty Ranges and nearby Kangaroo Island, South Australia. The mainland population is restricted to an area of approximately 150 km^2 of mainly high altitude stringybark forest (Read and Bedford, 1991) where its status is listed as vulnerable (Cogger, Cameron, Sadlier and Eggler, 1993). This note reports a 13 year old record of a pygmy copperhead from coastal mallee heath 35 km south of previously reported mainland sites.

Soon after dark on 28 November 1981 a specimen of roughly 350 mm total length was captured on the south-eastern boundary of 945 ha Newland Head Conservation Park, southern Fleurieu Peninsula (35°37'42"S 138°32'17"E). The site was less than 500 m from the coast and comprised dense mallee heath of low *Eucalyptus diversifolia* with an understorey of *Banksia ornata, Xanthorrhoea semiplana, Allocasuarina muelleriana* and *Calytrix glaberrima*. The substrate was predominantly white glacial sand with sparsely outcropping limestone. The specimen was held for photography and later released at the capture site.

Eleven other reptiles were recorded during the survey of the park, conducted 21-29 November. Among these were a gecko and six small skinks, known or likely prey of copperheads: *Phyllodactylus marmoratus, Bassiana duperreyi, Hemiergis decresiensis, H.peronii, Lampropholis guichenoti, Lerista dorsalis* and *Morethia boulengeri.* Also recorded were two large elapids, *Pseudechis porphyriacus* and *Pseudonaja textilis*, both potential competitors and predators of copperheads.

Prior to this record, the pygmy copperhead was not known from coastal sites on the mainland, despite specific searches of these areas, including Newland Head (Read and Bedford, 1991). Importantly, this record establishes mallee heath as legitimate habitat for the mainland population. The Newland Head site is floristically unlike any other mainland copperhead habitat, although the vegetation structure is similar to that at Cox Scrub Conservation Park from where two previous records are known. The Cox Scrub site consists of open scrub to tall open shrubland of *Eucalyptus baxteri, E.cosmophylla* and *E.fasciculosa* with many understorey species similar to the Newland Head site (Davies, 1982). In contrast to mainland sites, the Kangaroo Island population is widespread across most available habitats including coastal dune and heath, structurally similar to the Newland Head site. This record extends to four the number of mainland conservation areas from which it is known.

The fact that both *P.porphyriacus* and *P.textilis* were recorded at Newland Head seemingly challenges the theory by Read and Bedford (1991) that pygmy copperhead distribution may be constrained by competitive or predatory exclusion from large elapids. However, neither snake is known to commonly utilise dense dry heath; *P.porphyriacus* prefers wetter areas such as swamps and creeklines, and *P.textilis* prefers open savannah grassland. Neither species is reputedly common in the area (B. Carmichael, pers. comm.).

Given that the record was 13 years old, local field naturalists, park staff and an adjoining landholder were interviewed in July 1994 to establish additional records. None were uncovered and it is possible that this apparently isolated population may be extinct. If so, it is tempting to speculate that clearance in 1981 of 250 ha of mallee heathland adjacent to the capture site may have contributed to this. The conversion of this area to open grassland would not only

have reduced suitable habitat for copperheads, but also likely promoted encroachment by *P.textilis*, thus providing some support for Read and Bedford's theory. It is hoped that a forthcoming survey of pygmy copperhead distribution will show the above to be an unduly pessimistic assessment of the species status in the area.

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PREDATION OF AN EASTERN WATER DRAGON (*PHYSIGNATHUS LESUEURII*) BY A COMMON BROWN TREE SNAKE (*BOIGA IRREGULARIS*)

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Any observation of predation in nature is rare, yet each observation can help to clarify the complex picture of animal feeding habits. At 20:30 hours on the 2nd March 1994, while walking along a rainforest stream (Jimmy Creek) approximately 10km west of the Forestry Camp (now a J.C.U. research facility) in the Kirrama Range, north Queensland, Australia (145°41'10"E, 18°10'40"S) (map no. 8061-4, Kirrama, AMG 612 914), we were fortunate enough to observe the predation of *Physignathus lesueurii* by *Boiga irregularis*. When first encountered, the snake had only a tentative grasp of the lizard's head, and the lizard was still struggling, suggesting that the strike had been made very recently. During the next 20 minutes we saw the snake manipulate and swallow the dragon (Figure 1).

This record confirms that *P. lesueurii* forms at least part of the diet of *B. irregularis*. While other diurnal Agamid and Scincid lizards have been noted (Shine, 1991), this species has not previously been recorded in the diet of *B. irregularis*. This observation and others (Shine, 1991; Rhodda and Fritts, 1992) suggests that *B. irregularis* actively seeks refuging diurnal lizards.

This observation is important because it documents a nocturnally active snake preying upon a diurnally active lizard in its nocturnal refuge. Interestingly this is the reverse situation of an observation made by Hero and Magnusson (1987) of a diurnal snake preying upon a nocturnal gecko in its diurnal refuge.

P. lesueurii is frequently seen at night resting on small branches which are overhanging or adjacent to streams. When disturbed by lights or movement of the branch, the lizards jump into the stream. This behaviour is similar to that described for *Anolis gundlachi* (Clark and Gillingham, 1990) and thus we believe this behaviour to be an adaptive strategy used by *P. lesueurii* to avoid predation. The capture of *P. lesueurii* by *B. irregularis* clearly shows that the

arboreal sleep locations used by lizards are not always effective means of avoiding predation. Furthermore, it proposes interesting questions on whether *B. irregularis* can detect immobile prey (and if so how?) or catch lizards during their escape attempt following disturbance by the snake itself.

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Fig. 1. Predation of *P. lesueurii* by *B. irregularis*
(Photo: R.W.R. Retallick)

AGGREGATIONS OF *AUSTRELAPS LABIALIS*

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Aggregations of snakes in Australia have been reported for a number of species. Large basking aggregations have been documented for the Highland Copperhead, *Austrelaps ramsayi*, and Red Bellied Black Snakes, *Pseudechis porphyriacus* (Sault, 1977). Aggregations of gravid *P.porphyriacus* have been reported by Shine (1991). Shea, Shine and Covacevich (1993) cite references to aggregations of *A.ramsayi* basking prior to parturition, and Yellow Faced Whip Snakes, *Demansia psammophis*, at communal oviposition sites.

On the 15th November 1993 two aggregations of the Pygmy Copperhead *Austrelaps labialis* were located in the Murrays Lagoon/Hawks Nest area of Kangaroo Island, South Australia (approx. 35°50' south, 137°25' east). The time was 1200 (CST) and the temperature approximately 25 degrees.

The first aggregation of five large *A.labialis* were found under a large corrugated iron door from a shearing shed, measuring approximately 3 x 2 metres. Under a sheet of corrugated iron, 40 metres away, four more large specimens were discovered. Both aggregations were in the vicinity of a farmhouse and surrounded by agricultural land/cleared paddocks. Murrays Lagoon, a large area of wetland, was nearby.

Five of the nine snakes were collected, the remainder relocated at the request of the landowner. Of the five collected and retained, one (SVL 498 mm) was obviously gravid and another (SVL 431 mm) appeared to be so. These two plus another subsequently gave birth during the following February. Unfortunately the full details of all the captured snakes were not recorded, but the first mentioned female's clutch was born on 25/2/94 and consisted of 11 young averaging 2.3 grams. One of the remaining two captured copperheads was determined to be a male (SVL 503 mm). The sex of the other snake was unfortunately not determined.

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AN OCCURRENCE OF CANNIBALISM IN JUVENILE GREEN PYTHONS *CHONDROPYTHON VIRIDIS* WITH FURTHER NOTES ON THEIR CAPTIVE HUSBANDRY

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Cannibalism in reptiles is a naturally occurring behavioural trait that has been recorded in a number of species, (Mitchell, 1986; Polis, 1981). Grow (cited in Ross, 1990) noted the occurrence of cannibalism in neonate *Chondropython viridis*, whilst Gray (1977) reported a yellow hatchling *C. viridis* which overcame and ingested a red hatchling. The yellow hatchling died the following day after failing to completely regurgitate its sibling.

On 11 January, 1994 Taronga Zoo acquired 27 juvenile *C. viridis*. These were confiscated by The Department of Environment and Heritage, Queensland. The animals were reported to be approximately one month old and all were in one colour morph, bright yellow. They were initially housed separately in round five litre jars with perforated lids. Approximately 3cm of water was poured into each jar to maintain high levels of humidity. Air temperatures varied from 25-28°C. Eucalypt branches were used as climbing frames and resting perches. However, these soon began to foul the water and fungus started to grow on them. It was decided to discard the branches and replace them with plastic coated electrical cables, which were moulded into branch-like shapes. Pink mice were initially offered from forceps but were refused. Mice tails dipped in Avi-drops were force-fed to the snakes on a weekly basis for approximately 12 weeks, at which time newborn mice were again offered but were refused. The juveniles were then fed finely blended pink mice administered via a large syringe fitted with a length of 2mm (outside diameter) plastic tubing. The first voluntary feeding (of newborn mice) occurred in early May at approximately 19 weeks of age. An indoor plant mister was used daily to give the *C. viridis* a warm water spray, as this species is reluctant to drink from a bowl, preferring to lap up water droplets off vegetation or body coils.

In May animals were transferred into 4 wooden enclosures measuring 60 x 60 x 40cm, each housing between five and seven individuals. On 21 May 1994, one of the snakes was discovered with a grotesquely distorted abdomen. The animal appeared to be in some degree of discomfort and could not assume an ellipsoidal coil resting position characteristic of the species. On 25 May 1994, it regurgitated partially digested cage mate.

It was decided, after discussion within the Reptile Division, not to separate the snakes. The incident was considered to be aberrant behaviour, based on a review of the literature and personal experience. No further incidence of cannibalism has occurred in the subsequent 6 months.

PRODUCTS MENTIONED IN THE TEXT

Avi-drops: water soluble vitamin drops, manufactured by Medical Research (Marketing) Pty Ltd, North Ryde, NSW 2113, Australia.

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BOOK REVIEW:
FAUNA OF AUSTRALIA. VOLUME 2A AMPHIBIA & REPTILIA.

Edited by C.J. Glasby, G.J.B. Ross and P.L. Beesley.
Australian Government Publishing Service, Canberra. 1993. viii 439 pp. $A64.95.

The Zoological Catalogue and the Fauna of Australia series are together, when completely published, intended to document the known fauna of Australia. Whereas the Catalogue provides a complete list of the recognised taxa, families, genera and species, the Fauna series summarises the significant biological features of the groups. Although both sets of volumes are extremely valuable, the Fauna series is certain to appeal to a wider audience, from tertiary student, interested lay-person, wildlife authority to professional organismic biologist. The first volume of the Catalogue series is concerned with amphibians and reptiles (H.G. Cogger, E.E. Cameron & H.M. Cogger, 1983), and it is the companion to the book being reviewed below.

The Amphibia & Reptilia volume (2A) of the Fauna series consists of a Preface, nine colour plates, 42 separately authored chapters, literature cited sections for amphibians and reptiles, and an index. Forty-one specialists contributed to this incredible effort. The volume is superbly organised. Three chapters, titled General Description and Definition, History of Discovery, and Collection and Preservation, are devoted to each of the major taxonomic groups, Amphibia and Reptilia. In addition, there are Morphology and Physiology, Natural History, and Biogeography and Phylogeny chapters for the anurans, chelonians, squamates, and crocodylians. Well-illustrated keys are provided for the major taxa, including one for larval anurans. Still further, a separate chapter focuses on each family of frogs, turtles, lizards, and snakes. The general topics covered in each of those chapters are the same: definition and general description, history of discovery, morphology and physiology, natural history, and biogeography and phylogeny. Specific subject matter ranges widely, including commentary on external characteristics, body wall, skeletal system, locomotion, feeding and digestive system, circulatory system, respiration, excretion, sense organs, endocrine and exocrine systems, reproduction, embryology and development, life history, ecology, behaviour, economic significance, geographic distribution, affinities, and fossil record. Thus, detailed between group comparisons are expected to be relatively easily made because the basic subjects covered are much the same for each family.

Unfortunately, the actual execution of the book is not entirely satisfactory, both in terms of content and editing. For example, it is quite obvious that some of the chapters were hastily prepared and are incomplete surveys of the available information (Chapters 30, 32-34). There is also some redundant information (Chapters 40 and 41). Of general concern is the over-emphasis on categorical ranks, particularly in Chapters 12, 15, 23 and 29, and even to the point of appearing to ascribe reality to such classificatory conventions (p.249). Under-emphasised in my opinion are the physical characteristics of, and biology associated with, frog calls. Also, the structure and function of intromittent organs in reptiles are rarely mentioned (not one detailed illustration is provided of this incredible anatomical diversity). Also, I believe almost all of the sections concerning phylogenetic affinities do not do justice to the character evidence that is available in the literature. Moreover, plesiomorphic character states are frequently used to assess relationships (particularly in Chapters 7, 12, 23, 28 and 29), and that these sections misinform is evident in the emphasis usually placed on genetic distances (Chapters 5, 26, 29 and 31), with little or no mention being made of the criticisms that have been levelled at that source of information (see however Chapter 6). Likewise, the biogeographic discussions are disappointing, mainly because they emphasise a centers of origin-dispersal operating criterion (pp. 39 and 249), and do not entertain the possibility of a vicariance explanation. Also, there is some inconsistent taxonomy. For example, boinines is used for boines (throughout Chapter

33), *Chondropython* for some *Morelia*, *Christinus* for *Phyllodactylus*, *Liasis* for some *Antaresia*, *Lucasium* and *Strophurus* for parts of *Diplodactylus*, and *Pseudothecadactylus* for part of *Rhacodactylus*. Added to these distractions are a few misspelled names, such as *Anteresia* (p.285), *Chelosauria* (p.195), *Diplodactylus damaemi* (Fig. 27.7), *Python malurus* (Fig. 24.16), *Scaphioupus* (p.30) and *Varanus carlschmidti* (p.219). More troubling, however, is the all too frequent error of fact and unsupported or inconsistent information. For example, frogs are claimed to be eaten (p.11) or not (dust-jacket) by Aboriginals; abdominal ribs, or gastralia, are present in at least some squamates (p.157); gekkonids do occur in western South America (Fig. 26.2); at least a few pythonines, other than *Aspidites* lack labial pits (p.216); the interclavicle does in fact overlap the clavicles and I am unaware of a perforate interclavicle in any squamate (p.225); the ancestral karyotype of gekkonids may not be acrocentric (p.229); the highly variable karyotype observed in gekkonines does not by itself suggest the group is polyphyletic (p.231); acrodont teeth is not likely to be plesiomorphic at the level of Squamata, because other tooth-types are plesiomorphic in lepidosauromorphs, including basal sphenodontids (p.249); and amphibious varanids have a laterally compressed, not dorso-ventrally flattened, tail (p.253). That a few authors have taken the opportunity to argue a special position in such general review articles has not been particularly wise. A few references are missing from the Literature Cited sections (e.g. Calaby, 1974).

Still, there are several extraordinarily well done chapters, which include those by Margaret Davies and Phil Withers on Morphology and Physiology of the Anura (4), John Legler on Morphology and Physiology of the Chelonia (16), John Legler and Arthur Georges on Chelidae (21), Phil Withers and James O'Shea on Morphology and Physiology of the Squamata (24), Mark Hutchinson on Scincidae (31), Glenn Shea, Richard Shine and Jeanette Covacevich on Elapidae (35), Harold Heatwole and Harold Cogger on Hydrophiidae (36), and Gordon Grigg and Carl Gans on Morphology and Physiology the Crocodylia. These contributions not only contain few problems but they are absolutely packed with information. Further, the vast majority of the line drawings in the book are well executed and informative, and the half-tones well chosen. The labels on the illustrations are rarely problematic (see however unlabelled pedicel in Fig. 1.1 and clavicles and trachea [tch] in Fig. 27.4). The illustrations accompanying the keys are extremely useful. The color plates, while accounting for only 89 species, are beautiful. Generally, there is much to recommend this book. The reader must only be aware of those few chapters which are substandard, and the possibility that not all of the opinions and factual information presented in this volume of the Fauna series are equally well-founded.

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NOTES TO CONTRIBUTORS

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